For Editorial Contents see page 351

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

Engineering Library

JUN 2 1941

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY CHAS. COOPER AND J. FOSTER PETREE.

TEMPORARY OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 18 & 20, COMPTON ROAD, HAYES, MIDDLESEX.

VOL. 151—No. 3929. *LONDON: FRIDAY, MAY 2, 1941.* *Registered at the General Post Office as a Newspaper* PRICE 1s. BY FOREIGN POST 1s. 2½d.

Air Receivers, Buoys, Road Wagons Tanks, **TANKS** Hoppers, Chimneys, Ducting.
EVERYTHING FROM MILD STEEL PLATE.
JOHN BELLAMY
EAST 1802 LIMITED. Est. 1860
MILLWALL E.14 1216

J. & E. HALL REFRIGERATION
FOR LAND & MARINE PURPOSES
LIFTS AND ESCALATORS
J. & E. HALL, LTD., ENGINEERS, DARTFORD, KENT.
Telephone: Dartford 3456.
London Office: 10, ST. SWITHIN'S LANE, E.C.4.
Telephone: MANSION HOUSE 9811.
1263

PATTERNS
WOOD & METAL.
B. LEVY & CO. Osbert St., S.W.1
Vic. 1073

METAL SLITTING SAWS
GROUND FLAT STOCK
WILLIAM WARD & SON (SHEFFIELD) LTD.
CENTENARY WORKS, WOODSEATS ROAD, SHEFFIELD. 712

SECTIONAL PRESSED STEEL TANKS
also
RIVETED and WELDED PLATEWORK
STORAGE TANKS, BUOYS, CHIMNEYS, BUNKERS, HOPPERS, Etc.
BROWN, LENOX & CO.
(LONDON), LIMITED.
Contractors to the Admiralty since 1806.
MILLWALL LONDON, E.14.
Telephone: East 0700/1. 1342

GLOVES
For Steelworkers, Stokers, Miners, Welders. Women's munition gloves in Chamois or Leather.
MACPHAIL & KAY Ltd.,
WOODLEY, Nr. STOCKPORT.
See last week's ¼ page.

FOR HIGH CLASS
PATTERNS & MODELS
Phone: EUSton 3176 (4 lines).
GEORGE WAILES & CO. LTD.
382-6, EUSTON RD., LONDON, N.W.1.
Specialists since 1855 669

LOCOMOTIVES
STEAM OR DIESEL
HUDSWELL CLARKE & Co. LTD.
RAILWAY FOUNDRY, LEEDS.
London Office: 46, Victoria St., S.W.1.
Telephone: Victoria 1133 8550

SPENCER - BONECOURT
Patent Waste Heat Boilers
39, Farringdon Street, London, E.C.4. 1332

YARROW
& CO., LTD.
GLASGOW
SHIPBUILDERS
MARINE ENGINEERS 1353
LAND AND MARINE BOILER MAKERS

PETER BROTHERHOOD
PETERBOROUGH LTD.
STEAM ENGINES AND TURBINES
GAS AND OIL ENGINES,
AIR COMPRESSORS,
REFRIGERATING PLANT.
See Advertisement, Page 29. 6936

SPRINGS
FOR ALL PURPOSES
WILLFORD & CO. LTD., 1137
PARK HOUSE WORKS, SHEFFIELD, 9

DREDGERS
OF ALL TYPES
FERGUSON BROS. (Port-Glasgow), LTD.
PORT-GLASGOW. 1078

FORGINGS.
WALTER SOMERS, LTD.,
HALESOWEN 7116

WAGONS
HURST, NELSON & CO., LTD.,
MOTHERWELL. 3382

VISCO
AIR FILTERS
DUST COLLECTORS
COOLING TOWERS 1128
THE VISCO ENGINEERING CO., LTD.
Stafford Road, Croydon. Phone: Croydon 4181/5

FRASER
WATER-TUBE
BOILERS
'PHONE: FRASER & FRASER LTD. 'GRAMS
ADVANCE Bromley-by-Bow, PRESS,
3266 London, E.3. BOCHURCH, LONDON.

Research Engineers, Ltd., Northampton Grove, Canonbury, London, N.1. Design and construction of mechanical and electrical machinery and apparatus. Experimental work of any description. We have also a department for repetition work and precision machining at competitive prices. 1282

SPECIAL MACHINES
MADE TO ORDER
Parts and repairs
Erection of Plant
Millwrights work 1461
THOMAS HUNT & SONS
Westbridge Road. BATTERSEA, S.W.11.

COUPLINGS & DETUNERS
FOR ALL PURPOSES
THE WELLMAN BIBBY CO., LTD.
VICTORIA STATION HOUSE, VICTORIA STREET
LONDON, S.W.1.
Telephone: Victoria 7752.

BABCOCK

RAPIER
Builders of Europe's Largest
EXCAVATORS
RANSOMES & RAPIER, LTD
IPSWICH 1553 ENGLAND

CRADLEY BOILERS
CRADLEY BOILER CO., LTD., 1306
CRADLEY HEATH, STAFFS.

MUREX
Electrodes
MUREX WELDING PROCESSES LTD.,
WALTHAM CROSS, HERTS.
Telephone: Waltham Cross 3636.

MACROME treated **TOOLS** do more work in less time
MACROME
LIMITED
Z Dept.,
Head Office: ALCESTER, WARWICKSHIRE
Phone: ALCESTER 12.

CRANES
GEORGE RUSSELL & CO., LTD.,
Motherwell. 1317

ELEVATORS
BARRY, HENRY & COOK, LTD.
1304

Wanted Urgently — Schular Model TRSP or Comparable Make—BENDING, FLANGING and MOULDING MACHINE, arranged power drive. Approximate details:—Throat depth, 13½ in.; adjustable centres, 5½ in. to 19½ in.; sheet thicknesses up to 0·125 in. State best price and where machine can be inspected.—Address, L 367, Offices of ENGINEERING.

THOS. W. WARD, LIMITED
15 in. centres SURFACING and BORING LATHE on 14 ft. 6 in. flat gap bed, 2¾ in. diameter hollow spindle; admit between centres 7 ft. 9 in.; 30 in. diameter, 4-jaw indep. chuck. 3-step cone drive with double back gear.
No. 6 HERBERT COMBINATION TURRET LATHE, 22 in. swing, 2¾ in. diameter hollow spindle, 22 in. diameter 4-jaw indep. chuck, 3-step cone drive double geared.
12 in. centres S.S. and S.C. LATHE, on 24 ft. flat gap bed, solid spindle, 24 in. 4-jaw faceplate chuck, 23 in. diameter faceplate, 21 in. gap piece and c/shaft.
Write for "Albion" Catalogue.
ALBION WORKS, SHEFFIELD.
'Grams, Forward, Sheffield: 'Phone 26311 (15 lines) L 380

Alfred Herbert Ltd., Coventry PAY BEST PRICES for SECONDHAND MACHINE TOOLS in good condition, by first-class makers.—Write, wire, or phone, and our representative will call. 'Phone 88781 Coventry. Telegrams LATHE, Coventry. W 305

VALVE

On Active Service
COOPER SPLIT ROLLER BEARINGS
KING'S LYNN 1158 NORFOLK

WATER PURIFICATION PLANT
OF EVERY DESCRIPTION
JOHN THOMPSON
(KENNICOTT WATER SOFTENERS) LTD.,
WOLVERHAMPTON 1203

WATER TURBINES
GILBERT GILKES & GORDON LTD.,
KENDAL, ENGLAND. 1252

WATER SOFTENING
PATERSON ENGINEERING CO., LTD
82, KINGSWAY, LONDON 780

TAYLOR AND CHALLEN POWER PRESSES
TAYLOR AND CHALLEN LIMITED 1172
DERWENT WORKS, BIRMINGHAM, 19

SAMUEL PLATT
LIMITED
King's Hill Foundry, Wednesbury, Staffs.
DRAWBENCHES
FOR
AIRCRAFT WORK 689

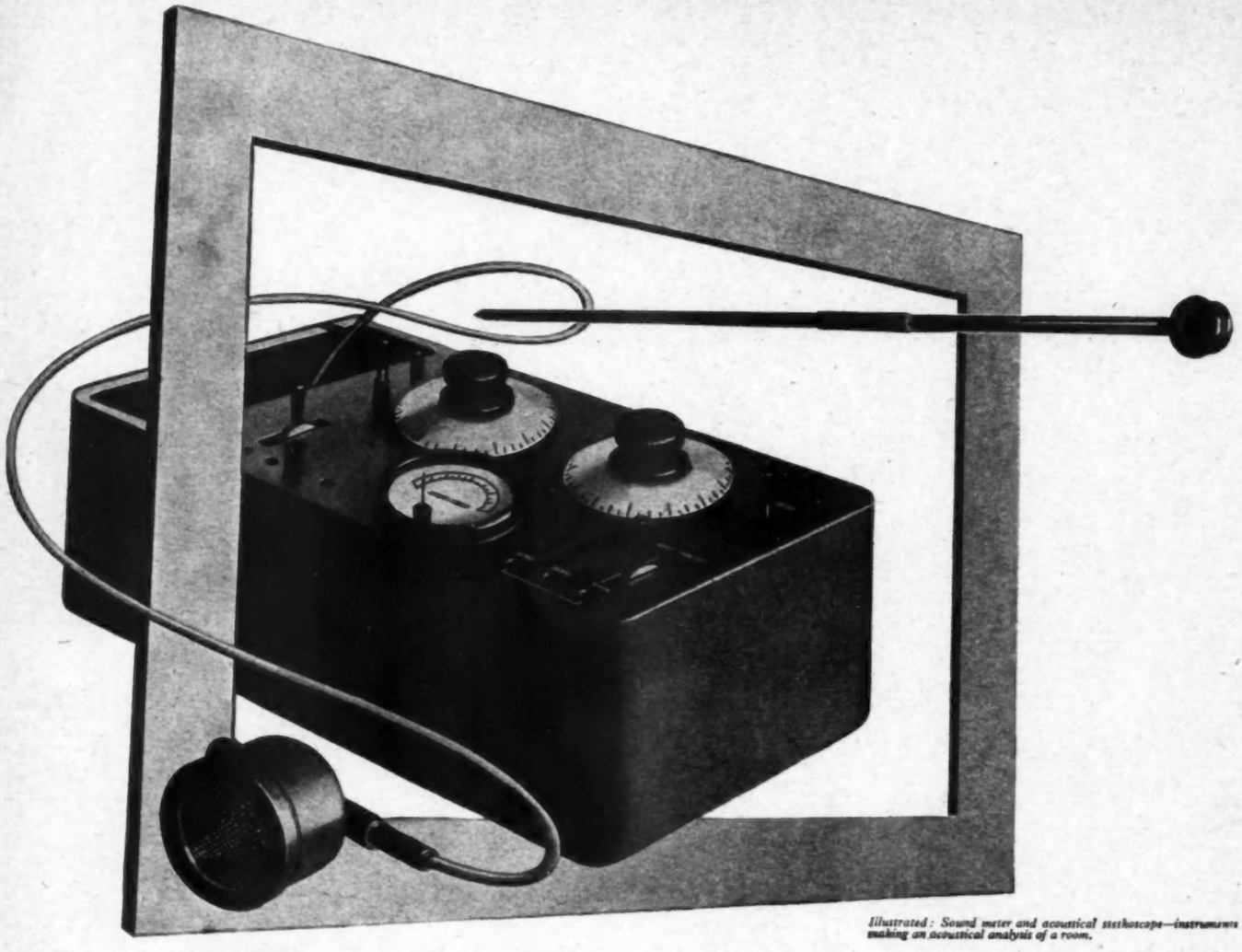
ALLDAYS & ONIONS
1132 LTD.
BIRMINGHAM.
HAMMERS PNEUMATIC & STEAM

"The machine with a BRAIN"
SCIAKY
SPOT WELDERS
SLOUGH —— 22342

LIGHTALLOYS LTD.
FIRST QUALITY
ALUMINIUM CASTINGS
ALPAX WORKS, St. Leonard's Road, Willesden Junction, London, N.W.10. Telephone: Willesden 3460-1-2. Telegrams: "Lightalloys-Phone-London."

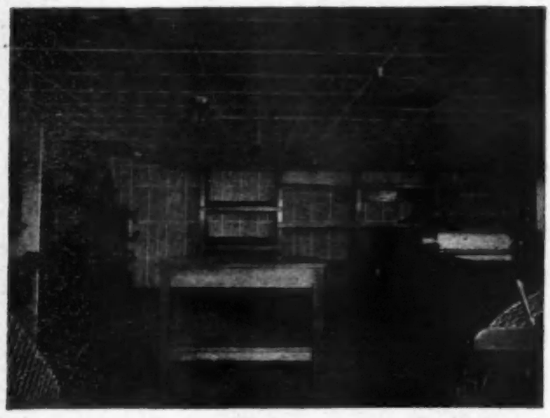
AIRPEL PATENT PUMPS
AIR PORT EQUIPMENT LTD.
AIRPEL WORKS, WEMBLEY, MIDDX.

VALUE 1334



Illustrated: Sound meter and acoustical stethoscope—instruments used in making an acoustical analysis of a room.

WAND AND MAGIC BOX



Acousti-Celotex applied to walls and ceiling of print room, R.M.S. Queen Mary.

Wand and magic box to you . . . but, in the hands of acoustical experts, accurate instruments to help solve noise problems. With their assistance, ACOUSTI-CELOTEX has made hospitals better places to get well in; has quietened A.R.P. and other vital control rooms; *and will subdue noise and help effort in your office and factory.* Sound control and acoustical correction are subjects you *ought* to know about. Let us send you the Celotex "Blue Book," a concise, objective summary of modern acoustical science. Write to: **Celotex Limited, Stonebridge Park, N.W.10.** or to your area distributor.

ACOUSTI-CELOTEX MEANS MORE OUTPUT

REGIONAL DISTRIBUTORS

HORACE W. CULLUM & CO. LTD., CONNAUGHT GARDENS, MUSWELL HILL, N.10—SOUTH OF CHESHIRE AND YORKSHIRE • WILLIAM BEARDMORE & CO. LTD., GLASGOW—NORTH OF THE CHESHIRE SOUTHERN BORDER, EXCLUDING YORKS. • J. H. BEAN & CO. LTD., 22, BASINGHALL STREET, LEEDS 1—COUNTY OF YORKSHIRE

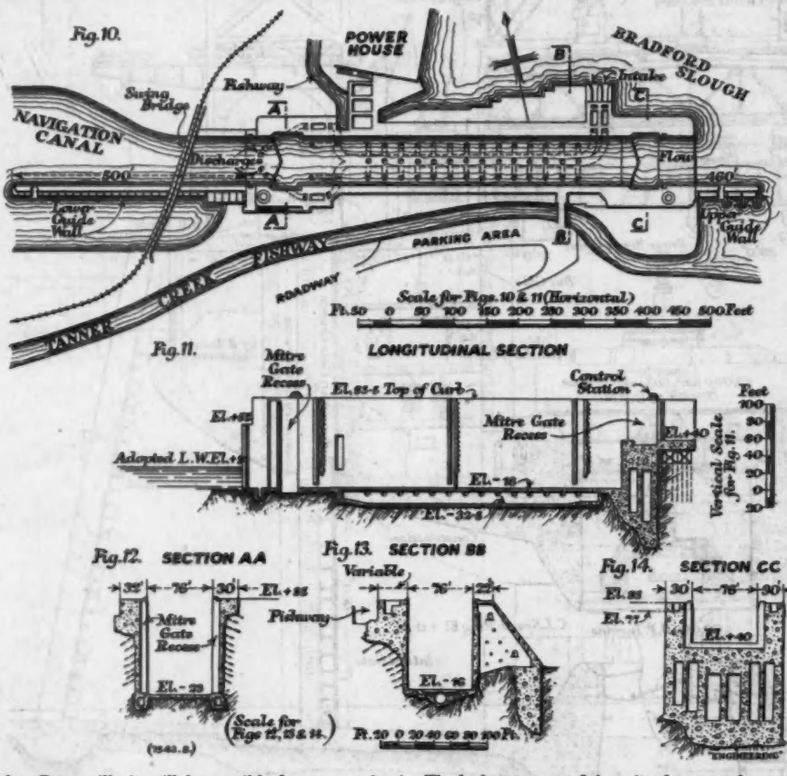
THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

(*Concluded from page* 303.)

As will be seen from the plan given in Fig. 1, on page 301, *ante*, the power-house dam incorporates a ship lock at its southern end, the channel for navigation passing through Bradford Slough, to the south of Bradford Island. The lock connects the navigable portions of the river above and below the dam and forms an important link in the facilities provided for the passage of shipping from the mouth of the Columbia River to Celilo Falls, or even to the confluence of the Snake River. Particulars of the various sections of the river are contained in the table which was given on page 303, *ante*. The completion of Bonneville Dam has resulted in the creation of a head pool with a depth of 30 ft. or more, and by further deepening of the channel below Bonneville it will be possible for ocean-going vessels to ascend the river to The Dalles. The dimensions of the lock have been determined with such traffic in view, and will permit of the passage of large ships.

From the description of the geological formation, which was given in the previous part of this article, it will be clear that the Oregon shore offered better facilities for the construction of the lock than the clay, gravel and boulder formation on the Washington side of the river, and it was possible to excavate the lock chamber entirely in andesite rock, a silicate of alumina, lime and sodium, characteristic of the Andes Mountains, from which it gets its name. The exposed vertical sides of the rock were faced with concrete, which was anchored in position, any additional height necessary being obtained by gravity concrete construction built up directly from the rock. A plan, longitudinal section and cross-sections of the lock are given in Figs. 10 to 14, on this page, and from the three cross-sections the relation of the concrete construction to the natural rock formation can be seen. The lock chamber is 500 ft. long and 76 ft. wide, and at low water provides a depth of 26 ft. over the lower sill. The lift at extreme low water is 66 ft., which is claimed to be greater than that of any other lock so far constructed. At normal river flow, the lift is 59 ft., and at extreme high water, corresponding to the 1894 flood, 30 ft. The depth of water over the lower sill is 26 ft., or more, for 98 per cent. of the time, the depth over the upper sill being equal, or greater.

The lock is filled through an intake formed in the upstream end of the north wall, as shown in Fig. 10. This is fitted with two 7 ft. by 11·5 ft. Tainter gate valves, which control the flow to a 14-ft. diameter longitudinal culvert below the lock floor. The culvert, as shown in Figs. 10, 11 and 13, connects to ports in the floor which are all 4 ft. in diameter. The lock is emptied through the same port and culvert system, which, at the lower end, connects to two 7-ft. by 11·5-ft. Tainter gate valves, situated inside the lock walls. These discharge to culverts connected to five 6-ft. by 7-ft. floor ports located downstream from the lower gates. The culverts and ports are shown in Fig. 10, and the culverts can be seen in cross-section in Fig. 12. The lock can be filled or emptied in about a quarter of an hour.



The lock gates are of the mitred type and are constructed of silicon steel. They are built up of horizontal girders, 44 ft. long, connected by verticals and intercostals and faced with both plain and buckled plates. The lower gates are 102 ft. high, each leaf weighing 525 tons. They are formed with internal air chambers, so that the buoyancy reduces the weight on the supports. The upper gates are 45 ft. high. The operating machinery, located inside the dock walls, consists of gear sectors actuating struts connected to the gates. An electric drive is employed, operated from control stations situated at each end of the north wall. Outside each end of the lock there are guide walls, 500 ft. long, for the lower wall, and 460 ft. for the upper. Vessels moor alongside these if it is necessary for them to wait for a passage through the lock. Floating mooring-bits, recessed in the lock walls, are provided to steady vessels in the lock while they are being raised or lowered, this operation, as already explained, being performed in a very short period. The lock may be isolated from the river, in case of damage to the gates, by means of emergency dams consisting of horizontal bulkheads of 80 ft. span, which may be lowered into grooves recessed in the entrance walls. These bulkheads, which are constructed of nickel steel, are 4 ft. deep. There are 13 of them in all. They are lowered into position by fixed derricks on the south wall. A chain fender is provided above the upper gates to minimise the possibility of damage by incoming ships. The completed lock, alongside the power-house dam, is shown on the left in the general view, Fig. 19, on Plate XXVII.

It will be seen, on reference to Fig. 1, that the power-house dam has not been built in line with the spillway dam. Its situation near the lower end of Bradford Slough was chosen both to obtain the maximum possible head for the turbines and to take advantage of the local andesite formation, which provided a suitable foundation. It is a reinforced-concrete structure, 608 ft. long, 180 ft. high, and has an overall width of 207 ft. It was designed ultimately to accommodate ten 43,200-kW generating units and one 4,000-kW house unit. The initial installation consists of two of the main sets and the house unit, but the superstructure for four additional main units has been completed. Two of these additional units are now being manufactured, and it has been found possible to increase the capacity to 54,000 kW each without important modification of the station structure. An abutment wall has been built at the north end of the station, behind which constructional work for the final four generating sets may be undertaken in the future.

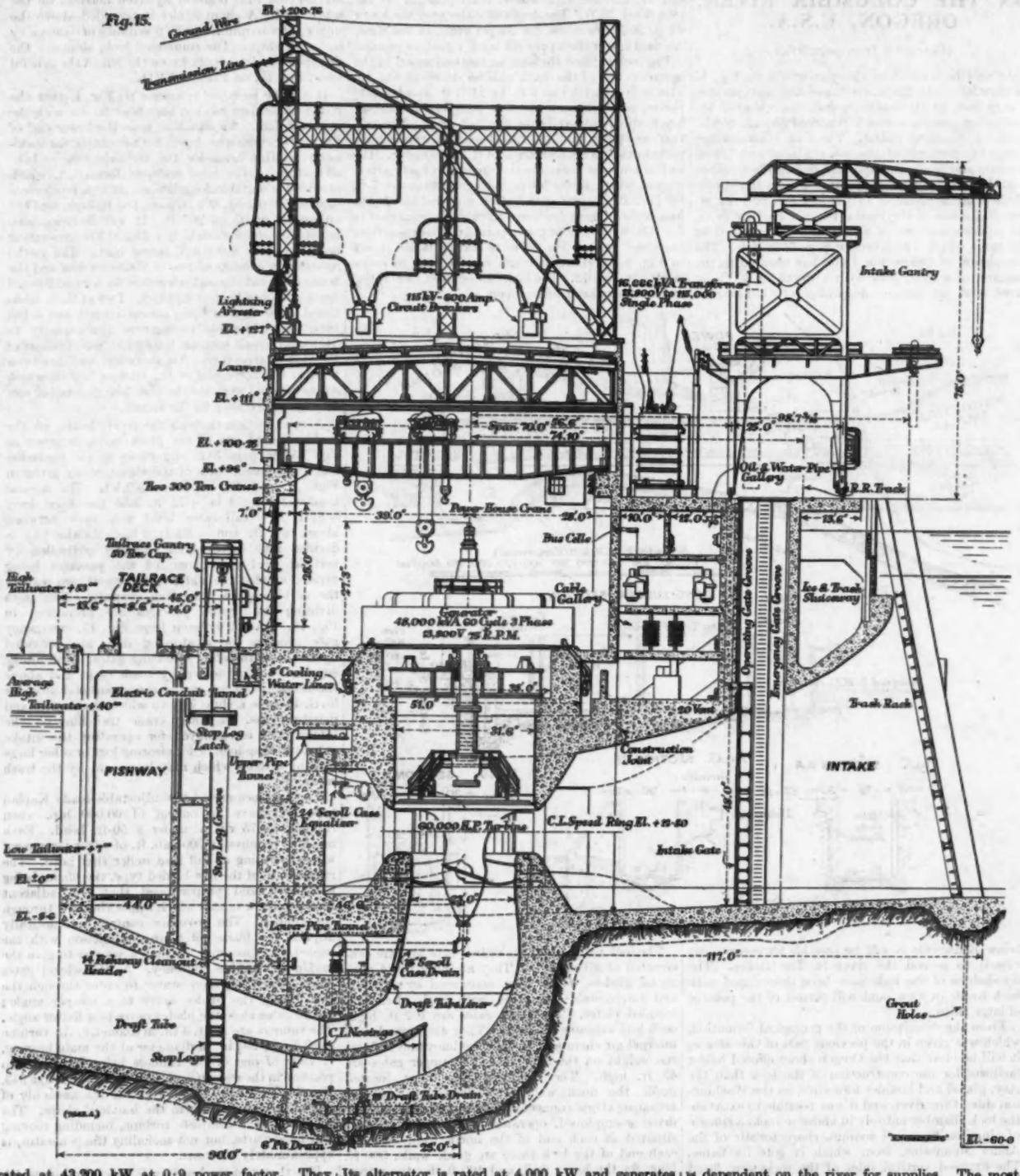
A cross-section through the power-house, on the centre line of one of the main units, is given in Fig. 15, on page 342, and views of the upstream and downstream sides of the structure are given in Figs. 16 and 17, on Plate XXVI. The normal head-water level is +72 ft. and the flood level +82·5 ft. Tail-water level will vary between about +8 ft. and +53 ft. Each intake bay is divided into three equal passages controlled by vertical steel gates, one of the passages being divided so that the water in the scroll case reaches the turbine gates from five channels. The piers dividing the intake passages are prominent in Fig. 16. As will be seen from Fig. 15, emergency gate grooves for a stop-log dam are provided upstream of the steel operating gates. The intake entrances are protected by trash racks and above the intake passages, in the neighbourhood of water level, there is a sluiceway to which floating ice and detritus pass. A gantry crane travelling on the intake deck is employed for operating the intake gates and stop-logs, or for clearing logs or other large floating articles which may be caught by the trash racks.

The turbines are of the adjustable-blade Kaplan type and have an output of 60,000 h.p. when running at 75 r.p.m. under a 50-ft. head. Each machine requires 12,000 cub. ft. of water per second when operating at full load under that head. The runners are of the five-bladed type, the blades being so spaced and proportioned that two adjacent blades form a nozzle which limits the flow through the runner. The governor control automatically adjusts the blade pitch, in conjunction with the wicket gate openings, in such a way as to give the maximum turbine efficiency. As the wicket gates open, permitting more water to enter through the speed ring, the blades move to a steeper angle; as the gates close the blades move to a flatter angle. The runners are 23 ft. 4 in. in diameter, the turbine shaft being 39½ in. in diameter at the main bearing. A view of one of the runners being lowered into position in the station is given in Fig. 21, on page 343, Fig. 18, on Plate XXVI, showing the assembly of one of the speed rings in the builders' shops. The weight of each complete turbine, including moving and fixed parts, but not including the generator, is approximately 900 tons.

The throat of the lined draft tube, through which the water leaves the turbine, is 23 ft. in diameter. As shown in Fig. 15, a cast-iron guide baffle is fixed in the draft tube in order to split the water stream and minimise eddies. There is also a vertical baffle, having the same purpose, which is not indicated in the illustration. Grooves for stop logs are provided at the downstream end of the draft tube in order that it may be isolated for inspection or repair. The logs are handled by a travelling gantry on the tail-race deck. The two main units are spaced at 82-ft. centres. The vertical-shaft generators are

THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

Fig. 15.



rated at 43,200 kW at 0·9 power factor. They have directly connected exciters with pilot exciters, and generate three-phase, 60-cycle current at 13,800 volts. The main transformers, situated in the open on the intake deck, step up from 13,800 volts to either 66,000 volts or 110,000 volts, as may be required for transmission. As shown in Fig. 15, the high-tension switching equipment is located on the roof of the building. The control gallery is alongside the turbine room at the level of the tops of the generators. The house turbine is of similar type to the main machines, but runs at 257 r.p.m. Its alternator is rated at 4,000 kW and generates three-phase current at 2,500 volts. The 2,500-volt switchgear is mounted in a compartment below the cable gallery, which is situated under the control gallery.

An interesting feature of the Bonneville Dam is provided by the elaborate system of fish ladders and passages which has been installed. The Columbia River and its tributaries form important spawning grounds for salmon and other migratory fish, and an extensive fishing industry, estimated to have aturn over of ten million dollars a year, is dependent on the river for supplies. The most important fish for which provision has had to be made are chinook, blueback, silver and chum salmon, and steelhead trout. Cut-throat trout are also found in relatively small numbers. All these fish spend the greater part of their lives in the ocean, entering the river only for the purpose of spawning. The young fish, hatched in fresh water, which are locally known as fingerlings, after a month or so begin to work their way to the sea. The fish remain in the ocean for from two years to five years, and then having attained maturity enter the river

THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

(*For Description, see page* 341.)

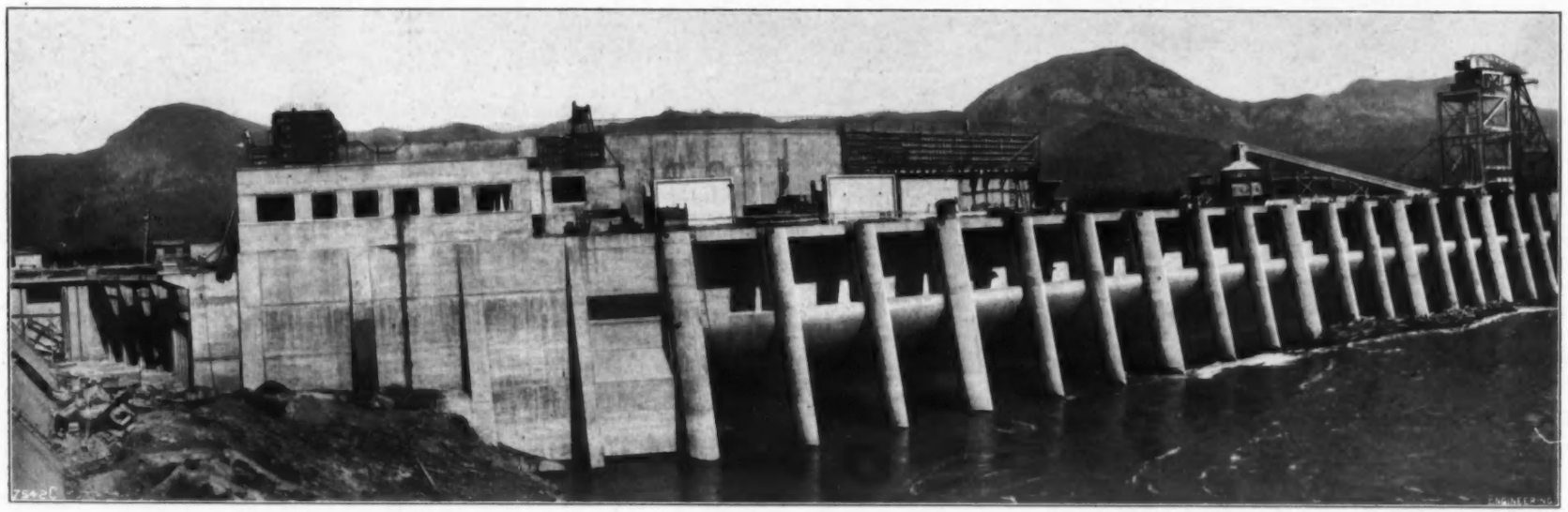


FIG. 16. UPSTREAM SIDE OF POWER-HOUSE DAM.

FIG. 17. DOWNSTREAM SIDE OF POWER-HOUSE DAM.

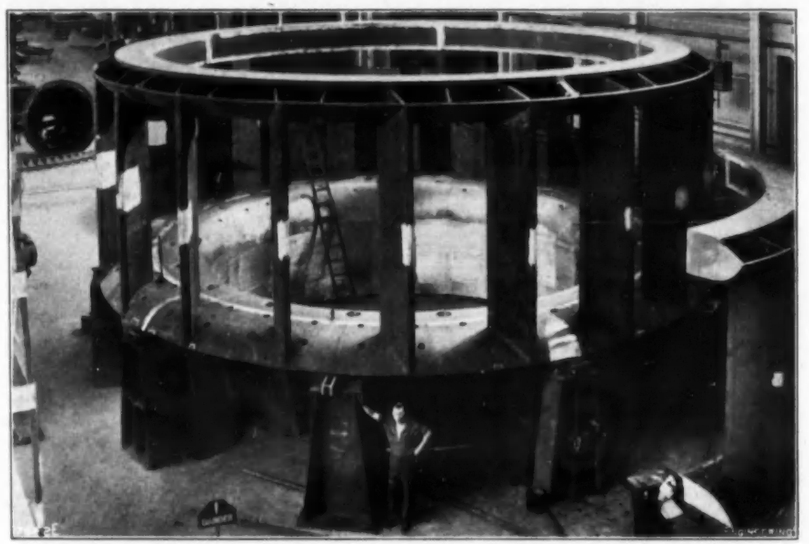


FIG. 18. TURBINE SPEED-RING IN BUILDERS' WORKS.

(*Between pages* 342 *and* 343.)

THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

(For Description, see Page 341.)

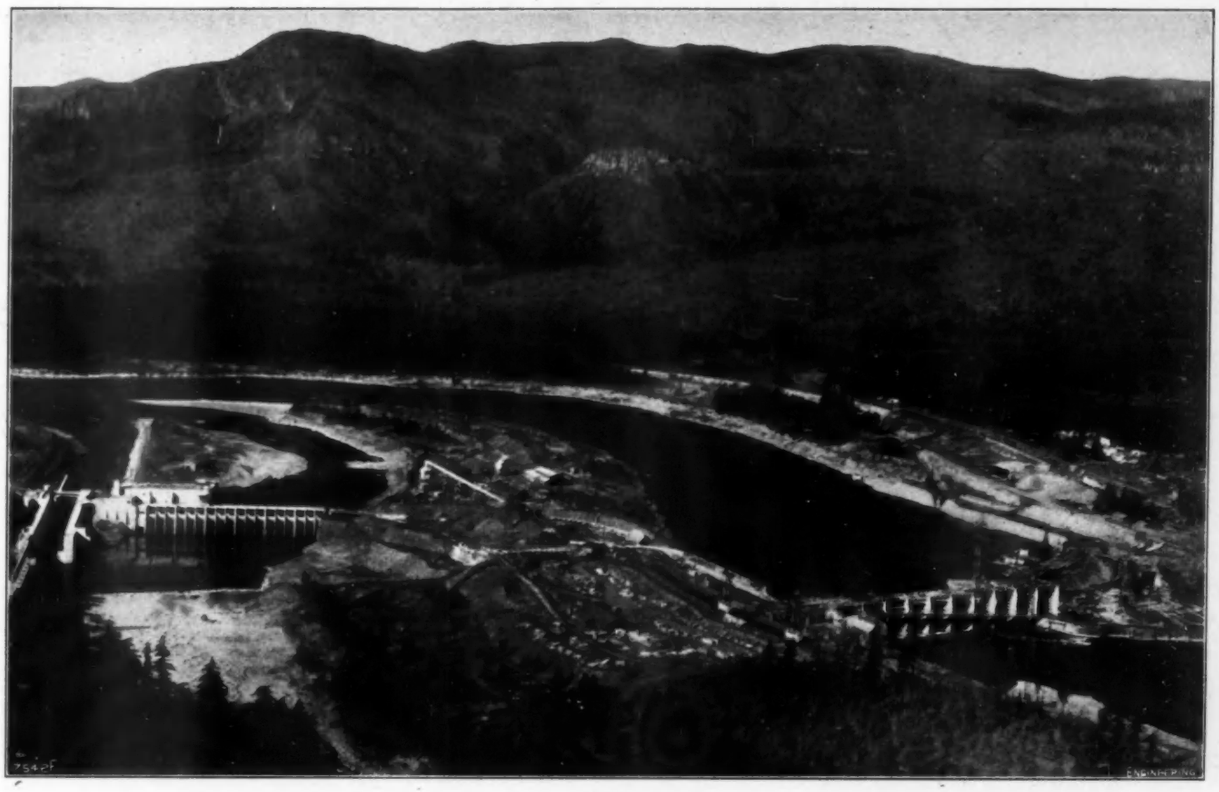


FIG. 19. GENERAL VIEW SHOWING SPILLWAY UNDER CONSTRUCTION AND POWER HOUSE AND LOCK COMPLETED.

FIG. 20. AERIAL VIEW OF WORKS NEARING COMPLETION.

(Between pages 342 and 343.)

UNIV. OF MICH.

THE BONNEVILLE DAM ON THE COLUMBIA RIVER.

FIG. 21. TURBINE RUNNER BEING LOWERED INTO POSITION.

and make their way to the spawning grounds. Some species die after spawning, others again make their way to the sea, and many even repeat the process for a third year. Other fish which have had to be provided for are the Atlantic shad, the sturgeon and the lamprey. The Atlantic shad was introduced in the Pacific many years ago and has become abundant in the Columbia River. It spawns mainly in the quieter waters below Bonneville, but is also found above the dam. Not much is known of the life history of the sturgeon, but it has been observed moving both up and down stream at Bonneville. The lamprey, which is very abundant, has a similar life history to the salmon. Although it is not commonly used for food in the United States, it was considered to be potentially valuable and worthy of protection.

The arrangements which have been made for the passage of fish cover collecting systems, lifts, ladders and canals. The general layout is shown in the plan of the dam given in Fig. 1, on page 301, *ante*. It was anticipated that fish approaching the spillway would endeavour to pass at the ends, but that those approaching the power-house dam would do so across the full face. Three sets of fishways have accordingly been provided, with entrances at these three places. Each fishway consists of a collecting system, a fish ladder and a pair of fish lifts. The ladder and lifts communicate with the same collecting system and may be operated together or separately. The collecting system at the power-house dam consists of a horizontal passage, extending across its full width, above the draft tube openings. It is shown in section in Fig. 15. The downstream wall of this passage is formed with a series of rectangular openings, which are prominent in Fig. 17. These contain weirs over which water passes to the tail race and over which the fish enter. Below the passage there is a series of diffusing chambers through which water from a pressure system may be introduced. In this way a current is produced in the passage so that the fish are directed either to the fish lift at the south shore or the fish ladder at the north end. A stop-log partition may be placed in the passage dividing it into two independent collecting systems, some of the fish passing to the lift and some to the ladder.

The fish lifts at the south end of the power-house dam, which are characteristic of the others, are rectangular shafts, 20 ft. by 30 ft. in plan. They have entrance gates 10 ft. square at the bottom, communicating with the collecting passage, and exit gates 8 ft. by 10 ft. at the top, connecting with the forebay. At the beginning of a cycle of operations the lift is empty. The entrance gate is then opened and water enters from the collecting passage, fish passing with it. The gate is then closed and the lift completely filled from an independent supply system. The exit gates are then opened and the fish pass to the forebay, following the current formed by the flowing water. To ensure that the fish shall leave the lift, however, it contains a loose slatted floor which is slowly raised so that the fish congregate at the top of the lift. The exit gate is then closed, the lift drained, and the cycle repeated. As the lifts are in pairs, there is always one open for the entrance of fish from the collecting passage. The time of a complete cycle for each lift is about 15 minutes.

The fish ladders, in general, are of the well-known type, consisting of a series of pools, each higher than the next, extending from the higher to the lower level. Owing, however, to the fact that the water level below the dam may vary by as much as 40 ft., with the usual arrangement, the entrance to the ladders at the spillway dam at high water would be several hundred feet away from its position at low water. In order to give a fixed location for the entrance, the ladders are provided with side walls extending to high-water level. An auxiliary water supply is also provided in the channel formed inside these walls, so that a definite current is produced, tending to guide the fish to the ladder. The Tanner Creek ladder, the position of which is shown in Fig. 1, consists of three independent ladders connected by level canals, 40 ft. to 50 ft. wide and 5 ft. deep. They have a combined length of 3,500 ft. The fish ladders on Bradford Island can be seen in the aerial view reproduced in Fig. 20, Plate XXVII.

It will be understood that the description so far given refers to the control of fish migrating upstream. For downstream migrants four by-passes have been provided, one at each end of the spillway, a third between the power-house and navigation lock, and a fourth south of the lock. These by-passes are similar to the fish ladders, but the pools are smaller and the drops between them greater. The ice and trash sluiceway shown above the intake in Fig. 15 also provides a passage for downstream migrants. Many will pass over the spillway, although in general they tend to avoid the high velocities of the mid-stream water and are found mainly in the quieter area alongshore. It is probable, however, that many fingerlings will pass through the power-house turbines. Both laboratory and field tests indicate that they may do this with little danger of injury.

As mentioned earlier, one of the most interesting problems which had to be solved at Bonneville was the method to be employed in damming the main stream during the building of the spillway. In the case of the power-house dam, it was possible entirely to close Bradford Slough by means of earth-filled cofferdams, during the construction period, and no unusual difficulty was encountered. A similar procedure could not be followed with the main stream, and it was necessary to arrange to carry out the building of the spillway in two stages. The river is 1,000 ft. wide, with a rough and irregular bed, the depth ranging from 40 ft. to 70 ft., and the velocity at times reaching 10 miles an hour. In arranging the constructional programme, it was also necessary to provide for the fact that during flood seasons the works would be inundated. A plan of the method employed is reproduced in Fig. 24, on page 350. The south half of the site was first unwatered* inside a cofferdam built-up of rock-filled cribs. Inside this the south half of the dam was built. The cofferdam was then removed and the river diverted through the spillway panels of the completed half of the dam. As explained in the first part of this article, the spillway weirs were not built to their final height at this stage, in order to leave a freer passage for the river. The cofferdam for the northern half of the river was then constructed and the other section of the dam built.

This apparently straightforward programme proved to entail many great practical difficulties. In view of the irregular form of the river bottom, it was necessary to shape the lower edge of the cofferdam to a corresponding contour. Soundings were accordingly taken, but owing to the deep swift water in which the work was being carried out, it was found that a wire cable carrying a heavy sinker did not reveal the shape of the irregularities with sufficient accuracy. The matter was finally dealt with by constructing a special sounding rig consisting of four vertical pipes, spaced at 4-ft.

* It was incorrectly stated on page 303, *ante*, that the northern half was first dealt with.

centres, and rigidly attached to the downstream end of a steel barge. The pipes extended downwards to within about 10 ft. of the average level of the river bottom. The position of the barge was controlled by means of a mooring cable, extending upstream, and manœuvring cables carried to the shore, and it was possible to locate it in any desired position over the site of the cofferdam. As it was worked over the area, steel rods, passing through the vertical pipes, were lowered to the bottom. This arrangement enabled soundings, at 4-ft. centres in each direction, to be obtained over the desired area.

The cribs from which the cofferdams were built were constructed of 10 in. by 12 in. and 12-in. square Douglas fir timbers, crossed and bolted together to form cells 12 ft. by 12 ft. in plan. The cribs varied in size from 60 ft. long by 36 ft. wide to 60 ft. by 60 ft. The average height was from 55 ft. to 60 ft., but in some cases the unprecedented height of 63 ft. was necessary. The weight of the larger cribs was about 1,400 tons. They were formed with pockets which were filled with rock when they were sunk, and the interior cells, which were filled with impervious earth when the cribs were finally in position, were lined with tongued-and-grooved boarding. The cribs were built on shore, on sloping launching ways, to a height of about 15 ft., the additional height being gradually added as they were sunk in position. After launching, they were manœuvred to site by means of three cables carried to winches on the shore. In some cases the pull on the cables reached 800 tons, owing to the swift current.

As the cribs were being sunk in position, soundings were taken from the top through sink pockets, in order to determine if the bottom was making a proper fit on the river bed, each crib having been built for the position it was to occupy. Divers, working in the sink pockets, were employed to check the soundings and to locate any point of contact between projecting rocks and the crib bottom. In a few cases, boulders which prevented proper seating were removed by blasting, and in one case some timbers at the bottom of a crib were blasted away to permit it to settle properly. In the plan showing the arrangement of the cribs, which is given in Fig. 24, it will be understood that the two cofferdams shown did not exist at the same time, although some cribs, such as Nos. 7, 8, 13 and 14, formed part of both cofferdams. In building the south cofferdam, crib 13 was first placed, followed by 12 to 8, successively, these forming the river arm. The two shore arms were built simultaneously, cribs 5 and 16 being the two closing cribs.

A protecting face of interlocking steel sheet piling was driven so as to rest against the river face of cribs 4 to 17, inclusive, those being farthest out in the river. Outside the sheet piling, a series of T-piles, at 12-ft. centres, was driven. These were provided in order to permit the driving of a second line of sheet piling at any point which exhibited unusual leakage and where there were signs of a break in the interlock. The T-piles ensured effective nesting of the second line of sheeting against the main piling. Actually, it proved necessary to drive loops of secondary piling in two or three positions. The remaining cribs, nearer inshore, were faced on the river side with 3-in. tongued-and-grooved sheathing. This south cofferdam was constructed without mishap and proved entirely satisfactory. It was not damaged during the inundation of the works caused by the summer flood of 1935 and to which it was known that it would be subjected. A point of interest in connection with the crib construction is that when the inside area had been unwatered, the cofferdam had a deflection of from 12 in. to 18 in. at the top.

As each crib was built to suit the position it was to occupy, it was not possible to utilise those of the first cofferdam for the construction of the second. On the completion of the work on the first half of the dam, cribs 1 to 6 and 15 to 20 were accordingly removed by blasting. A number of 3-in. steel pipes had been built into the corners of the 12-ft. cells. Charges of dynamite were inserted in these and exploded, the timbers being sufficiently shattered to permit of their removal by a dipper dredge and dragline. These machines at the same time removed the earth fill with which the cells had been loaded. The operation of blowing-up one of the cells, for which 2 tons of explosive were used, is illustrated in Fig. 22, on page 350.

The second cofferdam was constructed in the same manner as that already described for the first, the programme being arranged on the assumption that it would be completed well in advance of the summer flood of 1936. As indicated in Fig. 24, it was possible to construct the river arm of this second cofferdam as a continuous bulkhead inside the protection of the first cofferdam. The shore arms had, however, to be built up of timber cribs. On April 10, considerably in advance of the normal time of the summer flood, the river began to rise when four of the 60-ft. cribs of the downstream shore arm had still to be placed. In five weeks, the river discharge increased from 77,000 cusecs to a maximum of 520,000 cusecs, three successive peaks being passed during this period. Overtopping the upstream arm, the flood found a ready passage through the gap in which the four downstream arm cribs had not been placed. The water developed a differential head between the two sides of the upstream arm, with the result that the earth-fill inside the cribs was rapidly eaten away, together with the neighbouring bank face. Finally a gap 130 ft. wide and 75 ft. deep was scoured between the north river bank and the nearest crib. The velocity of the water through this gap rose to 20 ft. a second. This mishap was entirely due to the unexpected early arrival of the flood. Had both arms been completed in time, a relatively still pond would have been retained within the cofferdam and the greater part of the water would have passed over the earth fill of the cribs without serious damage as it had been covered with an 8-ft. thick layer of heavy riprap stone work. Actually, 42,000 cub. yd. of earth fill and riprap were washed out. Three nearly completed cribs of the downstream arm were carried away.

Immediately following the accident, the cribs which had been carried downstream were towed back into position and an attempt was made to close the breach in the lower cofferdam. Had this been possible, the repair of the wash-out in the upper cofferdam could have been carried out in relatively slack water, especially after the river had fallen by a few feet. Owing, however, to the volume of water passing and the velocity of the stream it proved impossible to repair the south cofferdam, and attention had to be directed to the closing of the 130-ft. gap through which the water was flowing. Dumping rock from barges was first tried, but the operation proved slow and very difficult, as owing to the stream velocity the heaviest rocks which could be handled were carried so far downstream before they settled on the bottom that the position in which they came to rest could not be controlled. Had it been possible to build a trestle across the gap, the rocks could have been dumped directly in position, but the water was too deep and swift to permit this. The situation was finally dealt with by building a trestle, 700 ft. long, from a point upstream to the shoreward end of the cribs in the upper arm. This was situated in shallower water moving with less velocity than in the peak itself.

From this trestle, blocks of stone, ranging from 6 tons to 30 tons in weight, and averaging 14 tons, were dumped on the site of the toe of the fill by which the gap was ultimately to be closed. As the stream struck this material at an acute angle, instead of directly, as would have been the case with rock dumped immediately across the gap, it was not subjected to the same disturbance and it was found possible to build up an underwater dam. To hold and steady the rocks, a series of 6-in. pipes was placed between the outer portions of the trestle bents. The pipes were simply lowered into place with their ends resting on the rock, no attempt being made to drive them into the bottom. The rock dumped around the pipes anchored them in position, while they, in turn, stabilised the rock pile. In this way a heavy rock bank was built up. Smaller material was then added and finally an impervious clay bank on the upstream side. With the completion of this work, it was possible to proceed to the repair of the cofferdams and when these were completed, the area between them was unwatered and the building of the dam carried on according to programme. Some idea of the difficult conditions under which the whole of this work was carried on may be obtained from Fig. 23, on page 350. This shows the placing of the last crib in the upstream arm of the second cofferdam before the wash-out took place. The crib is being placed in water 60 ft. deep and the illustration clearly shows the stream velocity which had to be contended with. As already mentioned, the pull on the anchor line during this operation at times rose to 800 tons. The extra expenditure caused by the wash-out was estimated at 150,000 dols.

LITERATURE.

Canning Practice and Control. By OSMAN JONES, F.I.C., and T. W. JONES, B.Sc. (Lond.). London: Chapman and Hall, Limited. [Price 32*s.* net.]

THIS work, first published in 1937, has now appeared in a revised and enlarged second edition, and, it may be justifiably claimed, one of greater utility, since the question of canned food, particularly home-grown food, has become of wider importance in the intervening four years. It is always a somewhat tedious business to ascertain to what degree revision has been carried out in a new edition, but a good idea of its extent in this case may be gathered from the bibliographies appended to nearly every chapter for, of some 250 separate titles, 32 at least may be identified as referring to books or articles appearing in the years 1938 to 1940. Such revision does not mean that the authors have had anything substantial to recant, the original parts of the work being still valid and pertinent, but is more in the nature of addition. Recent advances in tinplate manufacture, such as the continuous strip mill in which the strip passes directly to a continuous tinning plant, a cleaning and burnishing plant and, finally, to the stamping or drawing plant, are dealt with. Modern lacquering technique is also discussed, as well as the occurrence of such defects as electrolytic pitting and discoloration of the contents of the can by chemical action of the tinplate or its protective coating.

Chapter IV is completely new and deals with the packing of foods in glass containers, a form of packing which seems to be gaining in popularity. A description of the cannery laboratory and its work occupies approximately half the book, and of special interest to the engineer in this connection are the sections dealing with the examination of the can or glass. It may surprise some readers to find a statement that it is not possible at present to obtain tinplate with an absolutely uniform coating of tin and to see in the photographs of tests on can lids for evenness of coating how defective this coating can be. This is important as, for many purposes, evenness of the protective tin is a more vital factor than thickness. The chapters dealing with the examination of the food, its preparation and the deterioration that may be set up by various organisms are dealt with very fully and the descriptions of the manipulative technique for bacteriological examination are eminently lucid. The effect of canning on vitamin contents, an aspect now being given great prominence, is largely new. In general, every section of the book seems to have been brought up to date.

A number of illustrations have been added and it is in this connection that we have our only adverse criticism to make. With a few exceptions, the illustrations are not embodied in the text, but are grouped in batches of plates. Thus, Fig. 62, in the text, is followed by Figs. 44 to 61 in a batch, and then Fig. 63 in the text again. The majority of the illustrations are not alluded to by figure numbers; many, indeed, do not seem to be mentioned at all in the text, but rely on their captions. In our view, the book would gain if the more usual plan of referring to every illustration at an appropriate place in the text were followed. As it is, many of them may be overlooked or scarcely glanced at. Incidentally, one of the illustrations in the text, namely, Fig. 83, on page 173, is printed upside-down.

REPRODUCIBLE FLAME FOR TESTING ELECTRICAL INSULATING MATERIALS.*

By H. L. D. WYMAN, A.M.I.E.E.

(*Concluded from page* 323.)

Effect of Variations in Mesh of Flame Gauze upon Flame Temperature.—As previously stated, the base of the flame is located at an inverted gauze cup situated 1½ in. below the top of the burner tube. This facilitates the conduction of heat down the tube to the wire packing, thus ensuring the continuous action of the burner. As, through damage or usage, this gauze might need replacement, it was considered desirable to determine the effect of employing a gauze of different mesh. To this end, four cups of similar size were made from 20, 30, 60 and 90-mesh iron wire gauzes, respectively. The results obtained were as follows:—The 20-mesh gauze (average temperature 1,165 deg. C.) gave a noisy, pointed flame, which tended to burn back to the jet, and was unsatisfactory. The 30-mesh gauze (average temperature 1,140 deg. C.), except that the flame was slightly less noisy, appeared to be identical with that produced by the unmodified burner, and was thus satisfactory. The 60-mesh gauze (average temperature 1,140 deg. C.) gave a comparatively silent flame, which, after a few seconds, tended to form at the top of the burner. On removal, the gauze was found to be badly oxidised, and of no further use. The 90-mesh gauze (average temperature 990 deg. C.) gave a weak and silent flame, which became unstable after about 5 minutes' operation. After a further 3 minutes the burner had cooled, so that the spirit was no longer vaporised. Both the 60-mesh and 90-mesh gauzes were thus unsatisfactory. The flame gauze normally fitted to the burner is of approximately 30 mesh, but is made of nickel wire of smaller gauge than the 30-mesh iron gauze referred to above. Although a gauze of this mesh gives the best results, it may be concluded from the above that a gauze having a mesh between the limits of, say, 25 and 35, would be satisfactory. It is recommended that new gauzes be of nickel and not iron wire, as the former oxidises less rapidly, and 30-mesh should be aimed at.

Temperature Gradient in the Flame.—The coal-gas flame of the Méker burner has, hitherto, been used for standardising work because of its relatively uniform temperature distribution in the flame and the corresponding absence of any pronounced conal regions of combustion. These features are principally due to the grille at the top of the burner. The conal regions are present in both the Bunsen and the Barthel burners and, with other features, render the former unsuitable for industrial testing. In the case of the latter burner, however, the upper extremity of this region does not extend more than a fraction of an inch above the top of the burner. Thus, the part of the flame made use of has a relatively uniform temperature; where the temperature at ½ in. above the top of the burner was 1,190 deg. C., that at 3 in. above it was 1,130 deg. C. Intermediate measurements suggested that the gradient between these limits was uniform. Similar measurements made by Messrs. Méker et Cie on a Méker burner of equivalent size showed a temperature gradient of 110 deg. C.—nearly twice that of the Barthel flame. Measurements made at several points across the flame indicated that, except at the extreme edge of the flame, the temperature was uniform. At the boundaries the temperature was about 200 deg. C. less than elsewhere. This region, however, is not more than $\frac{1}{16}$ in. thick, and is also common to the Méker burner flame. It is probably due to the fact that the boundary of the flame is cooled by being in contact with the atmosphere.

Use of Copper Wire to Check Operation of Barthel Burner.—The Barthel burner has been found by the writer seldom to need attention. It may occur, however, that, due to usage or to causes already mentioned, the flame produced by the burner has not exactly the required characteristics. As a check upon the flame, therefore, it has been found convenient to observe the time taken to melt a given copper wire placed in the flame. It can be shown from King's* formula for the cooling of hot wires that the rate of gain of heat by a thin wire in a flame is given by the expression—

$$h = l\,\theta\,(\sqrt{2\,\pi\,C\,\rho\,k\,v\,d} + (k)$$

where l is the length of the wire and d its diameter, θ the temperature difference between the wire and the main portion of the flame, v the velocity of the gases in the flame, C the specific heat per unit mass of the gases at constant pressure, k the thermal conductivity and ρ the density of the flame gases. With the exception of l and d, all of these quantities are liable to change with variations in the characteristics of the flame. Such variations are liable to occur if, for instance, the jet became clogged or the fuel contained some impurity.

A No. 22 S.W.G. bare copper wire inserted in the flame 2 in. above the top of the specimen and projecting ½ in. beyond the edge of the flame melted in an average time of 5·8 seconds. This was observed with a head of fuel of 30 in. With 40 in. head the average time to melt the wire was 4·6 seconds. The temperature difference corresponding to this difference in head is 20 deg. C. (see Fig. 8, page 323, *ante*), and changes of this order are thus easily detected. Similar tests on a representative Méker coal gas flame gave different results on different days, thereby confirming the existence of day-to-day variations in the temperature of such flames. The technique described is, however, subject to possible errors. One cause is due to the difficulty of accurately adjusting the length of wire extending beyond the flame. It was found by experiment that the average melting time was very dependent upon the length of this overlap when the latter was small, and approached a constant value when it exceeded 1 in. The advantage of a large overlap was, however, offset by the relatively large *variation* in melting time which then occurred. This may have been due to small deviations from a central position in the flame, but this is not certain. The average melting times for various lengths of overlap, together with the percentage variations and probable errors in these times are given in Table IV. The results were obtained as a result of 35 observations. The possibility of error referred to above could, no doubt, be reduced, if not eliminated, by accurate positioning of the wire in the flame. Despite this possibility, however, the method has the merits of simplicity and reasonable accuracy. A change in flame temperature of the order of 20 deg. C. can be detected with certainty by this means.

TABLE IV.—*Average Time of Melting of a No. 22 S.W.G. Bare Copper Wire.*

Fuel Head, 30 in.

Length of Wire Projecting Beyond Flame. In.	Average Melting Time. Seconds.	Probable Error of a Single Observation of Melting Time. Seconds.	Percentage Variation in Melting Time. Seconds.
0	3·91	±0·19	±3·1
¼	5·76	±0·18	±3·1
½	5·96	±0·36	±6·0
¾	7·10	±0·55	±7·8
1	8·41	±0·79	±9 4

Recommendations.—The most outstanding conclusion which results from the above work is that a reproducible flame can only result from a fuel of fixed composition. Coal gas is not of fixed composition except within limits which have been shown to be unsatisfactory for the purpose under consideration. The composition of industrial methylated spirit to British Standard Aircraft Specification No. 3.D.9 is, however, sufficiently consistent. Moreover, when used with the Barthel burner, this fuel has been shown to give results which are reproducible within very small limits.

These observations, coupled with the results given above, enable the following basic operating details (for the purpose of naked flame tests on specimens of insulating materials) to be prescribed:—The burner employed shall be the Barthel (No. 20 B) spirit burner as illustrated* and the fuel employed shall be industrial methylated spirit to British Standard Aircraft Specification No. 3.D.9. The burner shall be operated with the valve more than one-half turn open, and the level of the fuel 30 in. (± 3 in.) above the base of the burner. The satisfactory operation of the burner shall be checked as follows:—A bare copper wire 0·028 in. in diameter (No. 22 S.W.G.) having a free length of not less than 4 in. shall be inserted centrally in the flame at the level normally occupied by the specimen. The unsupported end of this wire shall project beyond the flame a distance of ½ in. From four to six observations of the time taken to melt the wire shall be made. If the average time of melting exceeds 6 seconds, it is an indication that the burner is not operating satisfactorily for the purposes of the test.

Acknowledgments are due to Mr. J. G. Clark, of the British Commercial Gas Association, for arranging facilities for tests to be carried out at several gas works.

* Being Report Ref. L/T. 75a of The British Electrical and Allied Industries Research Association, "Reproducible Flame for the Purposes of Naked Flame Tests on Solid Electrical Insulating Materials," by H. L. D. Wyman.

* King, *Phil. Trans.*, 1914, vol. 214, page 373.

* Or Baird and Tatlock automatic spirit Bunsen No. WDC 908.

NOTES ON NEW BOOKS.

The Mechanical Testing of Metals and Alloys. By P. FIELD FOSTER. Second Edition. London: Sir Isaac Pitman and Sons, Limited. [Price 18*s.* net.]

THE fact that the need has arisen for a second edition of a book originally published only about four years ago is an indication of the nature of the reception accorded to it and a measure of the intrinsic value of the work. The new edition is practically identical with the first, but the opportunity has been taken to include a few descriptions of recently developed testing equipment. The author, who is on the staff of the Engineering Department of University College, Cardiff, opens with a well thought-out and neatly illustrated chapter on the theory of elasticity. He follows this up with a short chapter on the structure of metals, in which he deals succinctly but fairly adequately—in the brief compass of ten pages—with such matters as the crystalline nature of metals, space lattice, metallic solutions, eutectics and atomic structure. Having thus disposed of general theory, the author proceeds directly with his main subject, namely, mechanical testing and the modern testing machine. He deals in successive chapters with universal testing machines; tension and bending tests; grips and shackles and other accessories; extensometers and recorders; torsion-testing machines; hardness-testing machines; notched-bar impact testing; fatigue-testing equipment; and elastic constants and the testing of wire and sheet metal. In each chapter a relatively large number of machines of various types is illustrated and described in detail, that dealing with repeated stresses and fatigue testing being specially complete. The last chapter, which is headed "Some Test Phenomena and Results," forms a fitting conclusion to the work; it deals with stress-strain curves, strain-hardening, hysteresis, types of fracture in the tensile and compression tests, and related subjects. The author devotes the last few pages to the influence of temperature on the mechanical properties of metals and deals very summarily with creep tests. Possibly from considerations of space, he deals with only one out of the many creep-testing equipments now in use, namely, that developed by the Metropolitan-Vickers Electrical Company, Limited. At the end of the work are to be found tables of the mechanical properties of some typical metals and alloys and a short bibliography of books, papers and articles on mechanical testing. While the volume is obviously mainly intended for the personnel of testing laboratories, it contains much of interest and value to the engineering student.

The Practice of Arc Welding. By W. HEIGH. London: Sir Isaac Pitman and Sons, Limited. [Price 5*s.* net.]

IN the early part of this book a brief description is given of three arc-welding processes, namely, the carbon arc, the more common metallic arc and the atomic-hydrogen process. The carbon arc is largely used in automatic plants, and the use of the hydrogen process, which is rather expensive, is almost entirely concerned with specific work, for which it is very suitable. The metallic arc, therefore, receives most consideration. There is a large field for automatic welding and the scope of such machines will doubtless be increased, but they deal with mass repetition work or a particular form of seam. As far as can be seen, most of the welding on structural work and built-up steelwork will always be a manual operation. The author has set himself a definite object and definite

limits—to deal with the practice of welding from the point of view of the artisan rather than the technician, with the intention of giving him a wider interest in his work. Manual welding can properly be termed a handicraft. The craftsman will learn by experience, but much more quickly and less expensively if information is available to point out the right direction. Two factors complicate this learning; it cannot be practised slowly, as once the arc is struck the weld must proceed at its proper speed; and, viewed through a welding glass, little is visible except the immediate vicinity of the arc, so that things must be reasoned backwards from the results. Some two-thirds of the book is devoted to the actual craft, commencing with "striking the arc," which, however simple it looks, demands some dexterity if it is to be done neatly. Excellent illustrations show how various faults can be detected, such, for instance, as slag traps, undercut, poor appearance, high or low current, and varying arc length. Distortion is always a trouble in welding and the author makes no attempt to disguise the fact. In several cases, a short analysis is given of the effects of different methods of procedure on distortion, hardness and liability to hair cracks. Among the tables given at the end of the book is one detailing the percentage of electrode consumption which should be allowed for loss due to unused ends, spatter and, in particular, for surplus metal. This table is worth attention. In this short book the author has included much useful knowledge that he has gained by careful study of both the craft and the men.

Introduction to Works Practice. Edited by E. MOLLOY. London: George Newnes, Limited. [Price 5s. net.]

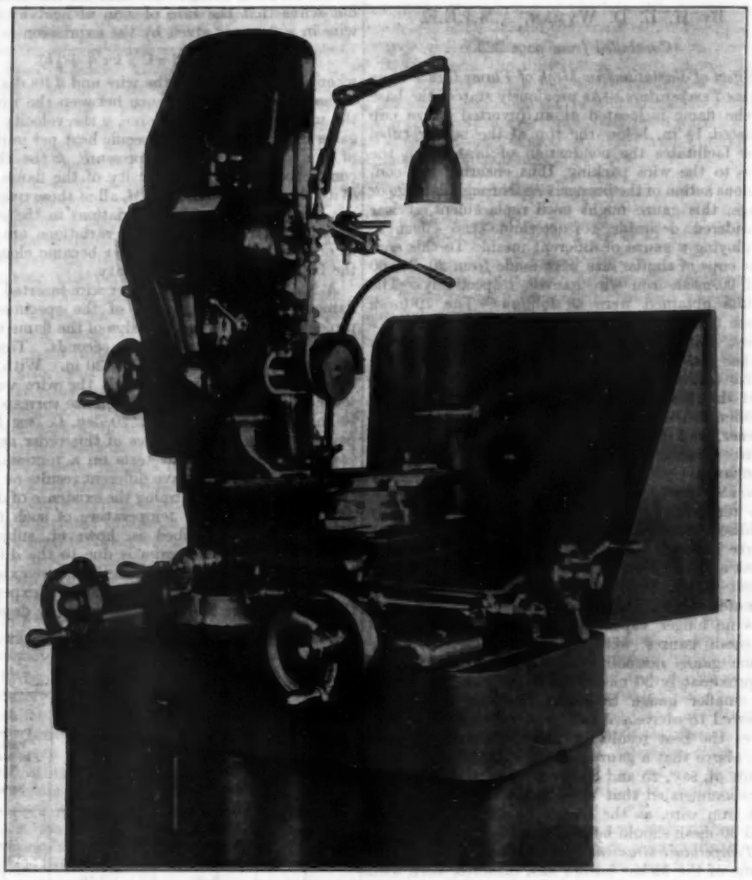
AN apprentice entering an engineering works usually finds it a bewildering place at first. Some works are small enough for the whole to be seen easily, but in larger establishments, without apprentice training schemes, it is difficult for the new recruit to grasp the many aspects of the trade he is learning. Ability to interpret a simple blue print correctly is required of the apprentice almost immediately and before long he will be introduced to the micrometer, vernier and other measuring instruments and will himself find the need of a knowledge of workshop mathematics. This small text-book has been compiled with that need in view. The first three-fifths of the book describes the production of an all-geared headstock centre lathe of modern design. Drawings, pattern making, moulding and drop forging receive due attention, while planning cards and progress charts are described and their uses indicated. The use of jigs, fixtures and gauges is considered and fits and tools touched on. Of the actual machining processes, planing, drilling, milling, surface grinding, gear cutting, key-seating, multiple boring and capstan and turret lathe work are described and illustrated. The photographs have especial value, since they show the components being passed through a single works in the manner in which the apprentice would see them. This method, however, leads to some omissions which might have been made good from other sources. Nothing is said about cylindrical, internal, spline, gear-tooth and cutter grinding. Shaping and slotting are not mentioned, while most serious is the failure to deal with the operation of the centre lathe, more especially as the product of the operations described is itself a centre lathe. Cutting speeds are touched on and it might have been helpful to have given some examples of the speeds and feeds used on the operations illustrated. Two chapters are devoted to reading blue prints, the micrometer and the vernier caliper, while the last chapter, on workshop mathematics, contains much useful information.

ZINC BROMIDE AND KEY INDUSTRY DUTY.—The Treasury has issued the Safeguarding of Industries (Exemption) No. 2 Order, 1941 (S.R. & O. 1941, No. 504, price 1d.) under Section 10 (5) of the Finance Act, 1926. The Order, which is effective from April 18 until June 30, 1941, exempts zinc bromide from Key Industry Duty.

INSTITUTION OF ELECTRICAL ENGINEERS.—The thirty-second Kelvin lecture of the Institution of Electrical Engineers will be delivered by Dr. S. Chapman, F.R.S., at 2.30 p.m., on Thursday, May 8, the subject being "Electrical Works by Helios, or the Sun and the Ionosphere." At the commencement of the meeting the Sir John Kennedy Medal of the Engineering Institute of Canada, at the request of the Institute, will be presented by the President, Mr. J. R. Beard, to Lieut.-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., Commander of the Canadian Forces in Great Britain. General McNaughton is an associate member of the Institution of Electrical Engineers. At the same meeting, the President will present the Faraday Medal for 1941 to Dr. A. P. M. Fleming, C.B.E., and the Cooper's Hill War Memorial Prize and Medal for 1940 to Mr. J. S. Forrest.

UNIVERSAL TOOL-GRINDING MACHINE.

MESSRS. HANNIFIN MANUFACTURING COMPANY, CHICAGO, U.S.A.



UNIVERSAL TOOL-GRINDING MACHINE.

THE term "universal" is employed in connection with the tool-grinding machine shown in the accompanying illustration to indicate that the adjustments provided enable it, in conjunction with appropriate fixtures, to be used for grinding such diverse tools as parallel fluted reamers, milling cutters, twist drills, and so forth, in addition to its employment in the operations of backing-off, relieving, circular grinding, etc. The machine, known as the "No. 5 Precision Tool Grinder," is made by Messrs. Hannifin Manufacturing Company, 621-631, South Kolmar-avenue, Chicago, Illinois, U.S.A., and is distributed in Great Britain by Messrs. Broadway Engineering Company, Limited, Carlisle-road, Hendon, London, N.W.9. The maximum size of grinding wheel that can be employed is 4 in. in diameter by 1 in. wide for a plain wheel and 1¼ in. wide for a cup wheel. The adapters provided, however, permit wheels as small as ½ in. in diameter to be used and of any thickness below the maximum. In order to provide correct peripheral speeds for wheels of different diameters a range of ten spindle speeds, from 3,600 r.p.m. to 35,000 r.p.m. under load, is available. A cooling-fluid pump prevents wheel glazing and reduces the risk of work-surface annealing.

The wheel assembly and driving motor are mounted on a saddle having vertical traverse on the column. The column can be rotated round the vertical axis to any angle up to 15 deg. on each side of the setting parallel with the centre line of the longitudinal table traverse, so that the grinding wheel spindle may be turned in the horizontal plane by this amount for such operations as taper grinding on work directly attached to the table. The spindle is driven by a balanced universal motor of ¾ h.p., having a built-in filter and forced ventilation system, through a flat endless woven belt, the ten speed variations being obtained by means of seven interchangeable pulleys. The spindle is mounted in pre-loaded ball bearings, the housings of which are rigidly held by a split socket formed integrally with the saddle. The saddle is traversed either by means of a rack and pinion for coarse adjustment or by a micrometer screw for fine feed, the length of traverse by means of the latter being 9½ in.

The table has a working surface of 13 in. by 9 in. and has manually-operated traverse in both longitudinal and transverse directions. The lead screws are of fine pitch and are hardened and ground. The transverse traverse is 5½ in. in both directions for coarse feed, which is effected by rack and pinion gear. The fine feed, effected by the lead screw and micrometer dial, is 2 in. at any one setting. All slides are made of Meehanite and are fully protected.

The machine is generally used with a sub-table or other work-holding device. Thus, the sub-table shown in the illustration is for work that can be held between centres. It has a graduated base for setting at any angle and will accommodate work up to 12 in. long. One of the centres is spring-loaded but has locking mechanism. This attachment is supplied as a part of the standard equipment of the machine, as is also a bracket for holding diamond wheel-dressing tools having a traversing slide and rotatable round the vertical axis. A wide variety of other fittings is, however, available, including, for example, a dividing head for grinding reamers and similar tools having straight flutes. This head is readily convertible into a cylindrical grinding attachment, the work being rotated by a small auxiliary motor on the head. There are also a fixture for grinding helically-fluted tools, the helix being generated from a master, a backing-off and relieving fixture, a fixture for the face grinding of form-relieved cutters, a fixture for dressing the wheel by means of a diamond tool, and a universal vice. All these fixtures are provided with large dials for accurate setting and are arranged to bolt directly to the table surface in the same way as is the centre fixture shown in the figure. Another fixture is a universal vice, which is adjustable in three directions, so that the work can be set in any plane tangent to a sphere.

RECIPROCATING HAND PUMP

MESSRS. AIR PORT EQUIPMENT LIMITED, WEMBLEY.

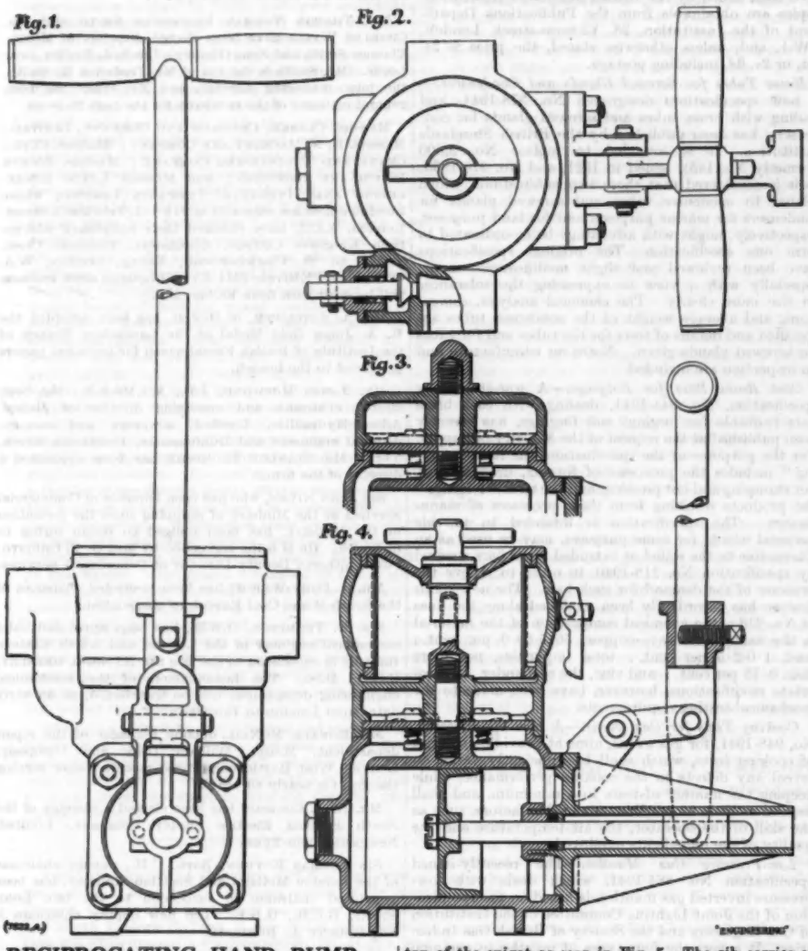


FIG. 5. PUMP WITH VALVE BOX REMOVED.

FIG. 6. VALVE PLATE.

RECIPROCATING HAND PUMP.

THE double-acting reciprocating pump has always had a high reputation for efficiency, but the valves usually necessitate a somewhat complex arrangement, which adds to the weight of the pump, and this is a drawback where portability and hand-operation are required. In the design shown in Figs. 1 to 6, on this page, simplicity and a reduction in weight relative to output capacity have been achieved without any sacrifice of efficiency or strength. The pump, to which the trade name "Airpel" has been given, is manufactured by Messrs. Air Port Equipment, Limited, Wembley, Middlesex. For the size shown in Figs. 1 to 4, which has a bore of 3 in. and a stroke of 3 in., a delivery of 9 gallons per minute can be maintained with 60 double strokes per minute. The general characteristics of the pump are such that it is possible to obtain a suction lift of between 26 ft. and 27 ft., without special precautions being required, and to maintain this lift. The delivery head naturally varies with the size of the pump, but it is stated that a normal head of 50 lb. per square inch is easily obtainable. The volumetric efficiency, with low suction and delivery heads, and with a normal rate of pumping, is claimed to be over 99 per cent.

Referring to Figs. 1 to 4, it will be seen that the pump is operated by a cross-handled lever, forked at the bottom as seen in Fig. 1, and having its fulcrum on a swinging link, as shown in Fig. 4. The short arm of the lever is connected to a crosshead attached to the piston rod and sliding in a sleeve bracketed from the cylinder cover, an arrangement necessitating, for the sake of simplicity, an internal gland. The piston is without packing rings and access to the piston nut is obtained through a plugged hole in the cylinder end. The cylinder is symmetrical and has two holding-down feet. It is finished at the top with a circular faced opening having a spigot. The opening is divided transversely by a rib the top of which is flush with the top of the spigot as seen in Fig. 5. The rib carries a central stud, which enables it to be identified in the sectional views, Figs. 3 and 4. From these it will be clear that each of the semi-circular halves of the opening formed by the rib communicates with one end of the cylinder. The opening is closed by a flat plate carrying two valves opening upwards, the discharge valves, and two opening downwards, the suction valves. A view of this plate is given in Fig. 6. It is held down on to the cylinder spigot by the central stud and the valve cover, as will be evident from both Fig. 3 and Fig. 4. The small hole seen at the top of the plate in Fig. 6 is for a dowel pin to prevent rotation, the pin itself being visible to the right of the central stud in Fig. 5.

Figs. 3 and 4 show alternative arrangements, Fig. 3 showing the valve box in its simplest form without a suction strainer, and Fig. 4 showing a deep incorporated strainer. In Fig. 3, it will be clear, the valve cover is divided by a vertical partition (not shown), the space at one side of this partition forming the suction box and that at the other forming the delivery box; both spaces have connections for the respective pipes. Occasionally, a pump may be required in which reversal of flow is necessary, and this can be effected in the Airpel pump by turning the valve plate upside down, it being unnecessary to alter the suction and delivery pipes. The valve box seen in Fig. 4 is necessarily of larger dimensions than that shown in Fig. 3, since the strainer has to be accommodated. It consists of a partially-spherical body with a horizontal partition in its lower part and a cover carrying the strainer above. One half of the chamber below the partition forms the delivery box, this chamber being divided by a vertical partition, as in the valve cover shown in Fig. 3, while the other half communicates with the inside of the strainer through holes in the partition and forms the suction chamber.

The bosses for the pipe connections seen in Fig. 1 will make it clear that these connections are in line, but that the delivery boss, on the left hand, has a port leading to the delivery chamber. The object of this arrangement is to enable the combined drain and relief valve, seen at the bottom left hand of Fig. 2, to be fitted. This valve is inserted between the suction and delivery chambers and is spring-loaded. If the delivery pressure is not to exceed a pre-determined limit the valve opens at this limit and short-circuits the pump. Sometimes, however, the tank or receiver served by the pump may have to be emptied and for this purpose a manually-operated lever with a locking-cam action is provided. This lever is seen to the right of the strainer chamber in Fig. 4, and when the valve is held open by its operation, the contents of the delivery tank, etc., flow back to the suction tank. The valves are all identical in construction and are of the flat-seated mushroom type, very lightly spring-loaded. The strainer consists of a cage of perforated copper over which is stretched a fine mesh screen. Gunmetal rings, brazed to the cage, centre the strainer, the bottom ring acting also as a seal between the inside and outside of the screen. The strainer chamber is held, and holds down the valve plate, by a nut on the central stud, as with the arrangement shown in Fig. 3, but the nut is itself prolonged into a secondary stud on which is a nut with a cross-handle. This nut rotates freely in the cover, being retained below the cover by a Seeger Circlip. The nut is rotated, as required, to drive the strainer home and make the cover joint or, conversely, to break the joint and free the strainer for withdrawal.

As regards details of construction, for petrol, lubricating oil, fuel oil and similar liquids, the main parts of the pump are made of cast iron with a steel piston rod and gunmetal valves. For water pumping, the main parts are of gunmetal, the piston rod being of steel treated by a rust-proofing process. For special services appropriate alloys are used. The operating lever is of steel tube, rubber handgrips being fitted to the crossbar. The fork and links are of gunmetal, the link pins being of high-tensile steel and being held in position by Seeger Circlips. Rubber shock absorbers are provided at each end of the slots in the crosshead bracket. In a modification of the pump, the method of flow-reversal is made still more easy. In this type, the valve plate is mounted so that it can be rotated, by means of an external handle, through 180 deg. in the horizontal plane. This makes

reversal possible immediately, without any joints having to be broken. When frequent transport is required, an ingenious arrangement of the pump is adopted. This consists of mounting it on a fabricated steel frame, supported under the pump by a wide roller and at the other end, which carries a seat, by two short legs. Operation is conveniently performed from the seat, which is folded down for transport, the frame being then handled wheelbarrow-fashion and run to the new site on the roller. This arrangement has been found to be very convenient. The Airpel pump is also manufactured for power operation, and these types are suitable for either direct drive or belt drive. Directly-driven pumps incorporate integral worm reduction gears.

BOOKS RECEIVED.

The Blue Book. The Electrical and Engineering Trades Directory. 1941. London: Benn Brothers, Limited. [Price 25*s.* net.]

Drawing and Development for Practical Welding. How to Overcome the Simple Distortion Problems. By F. W. SYKES. London: Sir Isaac Pitman and Sons, Limited. [Price 4*s.* net.]

Railway Board of India. Technical Paper No. 307. *Earthquake Reconstruction on Quetta (Railway) Division,* 1936-40. By R. O. C. THOMSON. Delhi: The Manager of Publications, The Railway Board of India. [Price 1 rupee 8 annas, or 1*s.* 3*d.*]

United States National Bureau of Standards. Building Materials and Structures. Report BMS 60. *Strength, Absorption and Resistance to Laboratory Freezing and Thawing of Building Bricks Produced in the United States.* By J. W. MCBURNEY and J. C. RICHMOND. [Price 15 cents.] Report BMS 63. *Moisture Condensation in Building Walls.* By H. W. WOOLLEY. [Price 10 cents.] Washington: Superintendent of Documents.

Raleting and Estimating for Engineers. By J. C. FREEMAN. London: Sir Isaac Pitman and Sons, Limited. [Price 7*s.* 6*d.* net.]

Canadian Pacific Railway Company. Annual Report for the Year Ended December 31, 1940. Montreal: Offices of the Company.

Aircraft Engines. Volume II. By A. W. JUDGE. London: Chapman and Hall, Limited. [Price 30*s.* net.]

An Outline of Metallurgical Practice. By PROFESSOR C. R. HAYWARD. Second edition. London: Chapman and Hall, Limited. [Price 38*s.* net.]

The Directory of Shipowners, Shipbuilders and Marine Engineers, 1941. Compiled under the direction of the Editor of *Shipbuilding and Shipping Record.* London: The Directory Publishing Company, Limited. [Price 20*s.* net.]

The Institution of Mechanical Engineers. Proceedings. Volume 144. *July to December,* 1940. London: Offices of the Institution.

Smithsonian Institution, Washington. Publication No. 3557. *Use of Solar Energy for Heating Water.* By F. A. BROOKS. Publication No. 3559. *Our Knowledge of Atomic Nuclei.* By DR. G. P. HARNWELL. Publication No. 3560. *Spectroscopy in Industry.* By DR. G. R. HARRISON. Publication No. 3567. *Our Petroleum Supply.* By H. D. MEIER. Publication No. 3569. *On the Frontier of British Guiana and Brazil.* By CAPTAIN H. CARRINGTON SMITH. Publication No. 3574. *Plankton in the Water Supply.* By FLORENCE E. MEIER. Publication No. 3580. *Historic American Highways.* By A. C. ROSE. Publication No. 3581. *Modern Trends in Air Transport.* By W. F. DURAND. Publication No. 3582. *The Story of the Time Capsule.* By G. E. PENDRAY. Washington: The Smithsonian Institution.

GRANTS FOR TRAINING CANAL BOATMEN.—The training of canal boatmen for the purpose of bringing back into service boats now lying idle is to be officially encouraged by the offer of grants payable to the carrying companies. Announcing the offer, in a letter to all canal carriers, the Minister of Transport, Lt.-Col. the Rt. Hon. J. T. C. Moore-Brabazon, states that the grants will be made towards the additional costs, arising from the employment of inexpert labour during the period of training, by reason, for example, of slower working and greater liability to damage. Grants will be at the rate of 10*l.* for each man trained and will be payable on the completion of the training period provided the Minister is satisfied that, as a result of training more men, the company has made a net addition to the number of boats in service. There is a further condition that employment shall continue for a year after training. To qualify for grant, carriers are asked to notify the Ministry of Transport, Metropole Buildings, Northumberland-avenue, London, W.C.2, of their desire to participate in the scheme, stating the number of boatmen now employed and the number of boats in use; how many men they expect to train and the net addition they hope thereby to make to the boats in service.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

Brass Tubes for Screwed Glands and Condensers.—A new specification, designated No. 378-1941, and dealing with brass tubes and screwed glands for condensers, has been published by the British Standards Institution. It is intended to replace No. 3,000 (formerly No. 145), issued in 1921, and No. 378-1930, as it is considered that these two publications, which related to condenser tubes and screwed glands for condensers for marine purposes and for land purposes, respectively, might with advantage be co-ordinated to form one specification. The original specifications have been reviewed and slight modifications made, especially with a view to expressing the tolerances on size more clearly. The chemical analysis, dimensions, and average weight of the condenser tubes are specified and details of tests for the tubes and for tubes for screwed glands given. Notes on manufacture and on inspection are included.

Cast Brass Bars for Forgings.—A war-emergency specification, No. 944-1941, dealing with cast brass bars (suitable for forging) and forgings, has recently been published at the request of the Ministry of Supply. For the purposes of the specification, the term "forging" includes the processes of forging, drop forging, hot stamping and hot pressing, and the term "forgings" the products resulting from these processes of manufacture. The specification is intended to provide material which, for some purposes, may be used as an alternative to the rolled or extruded brass bars covered by specification No. 218-1940, in order to relieve the pressure of the demand for such bars. The new specification has accordingly been modelled along the lines of No. 218; the chemical composition of the material is the same, namely:—copper, 56·5-60·0 per cent.; lead, 1·0-2·5 per cent.; total impurities, not more than 0·75 per cent.; and zinc, the remainder. Appropriate modifications, however, have been made to the mechanical-testing requirements.

Cooking Tests for Gas Ovens.—A new specification, No. 948-1941, for gas ovens, aims at providing a series of cooking tests, which shall be sufficiently varied to reveal any defects in the cooking performance, while keeping the number of tests to a minimum, and shall depend as little as possible on variable factors, such as the skill of the operator, the air temperature and the quality of the ingredients employed.

Low-Pressure Gas Mantles.—The recently-issued specification No. 884-1941, which deals with low-pressure inverted gas mantles, is based on the specification of the Joint Lighting Committee of the Institution of Gas Engineers and the Society of British Gas Industries. It covers the four types of mantles in common use, these being designated B.S. 1, 2, 3 and 4, respectively. The new publication specifies the dimensions of the mantles and their refractory rings, and the lighting efficiency of the appliance. In appendices are set out a test for breakage and distortion during burning, a shock test, and a test for determining the lighting efficiency. Particulars of the requirements to be satisfied by the test gas burner are also included.

Artificial-Daylight Fitting for Colour Matching.—A specification just issued by the British Standards Institution (No. 950-1941), which deals with artificial-daylight fittings for colour matching, contains the results of a considerable amount of research work. It relates to sources of light so designed that the light emitted by them is sufficiently close to daylight, in both colour and spectral-energy distribution, to enable these sources to be employed for colour matching or similar purposes. The specification requires that artificial sources of light for colour matching shall satisfy two conditions. In the first place, the colour of the light shall fall within certain limits, and, secondly, the difference between its spectral-energy distribution and that of the standard, as determined by an approximate filter method, shall be within certain limits. Considerable care has been taken in drawing up an appendix defining the filters, and the original proposals were slightly modified, after consultation with manufacturers of filters, in order to give as much tolerance as possible without, however, lowering the standard requisite for the necessary colour-matching requirements.

ROAD-TRANSPORT INDUSTRY EMPLOYEES AND MILITARY SERVICE.—As from April 28, all applications for the temporary deferment of the calling up of men engaged in the road-transport industry should be made to the appropriate Regional Transport Commissioner and not to the headquarters of the Ministry of Transport, as formerly.

PERSONAL.

DR. S. F. DOREY has been elected President of the British Association of Refrigeration, Empire House, St. Martin's-le-Grand, London, E.C.1.

MR. THOMAS NORMAN FREDERICK SMITH and MR. CHARLES WALLS have been elected directors of Messrs. Thomas Smith and Sons (Rodley), Limited, Rodley, near Leeds. Mr. Smith is the son of Mr. Frederick H. Smith, the joint managing director, and Mr. Walls has been general manager of the company for the past 20 years.

MESSRS. CLARKE, CHAPMAN AND COMPANY, LIMITED; MESSRS. E. N. MACKLEY AND COMPANY; MESSRS. CLYDE CRANE AND ENGINEERING COMPANY; MESSRS. JOSEPH BOOTH AND BROTHERS; and MESSRS. LEEDS ENGINEERING AND HYDRAULIC COMPANY, LIMITED, whose London offices are normally at 112-113, Fenchurch-street, London, E.C.3, have changed their temporary address from Kesgrave Cottage, Queensway, Gerrards Cross, Bucks, to 29, Castlebar-road, Ealing, London, W.5. (Telephone PERivale 2254/5.) All London office business will be dealt with from Ealing only.

MR. A. SUTCLIFFE, of Bolton, has been awarded the R. A. Jones Gold Medal of the Lancashire Branch of the Institute of British Foundrymen for technical papers presented to the branch.

MR. JAMES HOPWOOD, J.P., M.I.Mech.E., has been elected chairman and managing director of Messrs. Adams-Hydraulics, Limited, sewerage and sewage-disposal engineers and ironfounders, Peaseholm Green, York. MR. STANLEY THOMPSON has been appointed a director of the firm.

SIR JOHN NIVEN, who has been Director of Commercial Services at the Ministry of Shipping since the formation of the Ministry, has been obliged to resign owing to ill-health. He is being succeeded by MR. G. P. CHRISTOPHER, hitherto Deputy-Director of Commercial Services.

MR. G. CORY-WRIGHT has been re-elected chairman of the South Wales Coal Exporters' Association.

MR. E. THOMPSON, O.B.E., has been appointed chief mechanical engineer of the London and North Eastern Railway in succession to the late SIR H. NIGEL GRESLEY, C.B.E., D.Sc. The headquarters of the mechanical engineering department will be transferred, at an early date, from London to Doncaster.

MR. RONALD MCNEIL, outside manager of the repair department, Messrs. William Gray and Company, Limited, West Hartlepool, retired recently, after serving the firm for nearly 60 years.

MR. R. A. COOKSON has been elected a director of the North Eastern Electric Supply Company, Limited, Newcastle-upon-Tyne.

SIR THOMAS ROYDEN, Bart., C.H., deputy chairman of the London Midland and Scottish Railway, has been appointed chairman in succession to the late LORD STAMP, G.C.B., G.B.E. The new deputy chairman is SIR ROBERT A. BURROWS.

MESSRS. MACROME, LIMITED, Alcester, Warwickshire, have removed their Manchester office to 241, Deansgate.

THE EARL OF BESSBOROUGH has been elected President of the Royal Sanitary Institute in succession to LORD BALFOUR OF BURLEIGH, whose period of office has expired.

MESSRS. FERODO, LIMITED, Chapel-en-le-Frith, Stockport, inform us that their Manchester depot has been moved to new premises at 33-41, Nelson-street, Chorlton-on-Medlock, Manchester, 13. (Telephone Ardwick 3271.)

MESSRS. THE RUBEROID COMPANY, LIMITED, have transferred their London office to 1-19, Commonwealth House, New Oxford-street, London, W.C.1.

DAMAGE TO PROPERTY FROM QUARRY AND MINE BLASTING.—A lecture entitled "Man-Made Earthquakes" was delivered recently by Mr. S. L. Windes, seismological observer, U.S. Bureau of Mines, at the College of Engineering, University of Maryland. The lecturer reviewed the results of an investigation, extending over five years, relating to the measurement and interpretation of vibrations from quarry and mine blasting. Following a long series of tests to determine the possible damage to various types of buildings from earth vibrations set up by blasting at adjacent quarries, the Bureau had constructed a mechanical "house shaker." This was used to agitate various kinds of structures to a point at which actual, but controlled, damage was caused. The purpose of subjecting buildings to this "shaking-up" process was to ascertain the manner in which structures of the residential type vibrated; to correlate mechanically-induced house vibrations with ground vibrations from quarry blasting; and to establish an index of damage from ground vibrations. A number of buildings had been tested for susceptibility to vibration and had then been vibrated, by means of this mechanical house shaker, with such severity that the ceilings had fallen.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—Means whereby the district could increase its coal production in order to satisfy the ever-growing demand for Welsh coals were again engaging attention during the past week. It will be recalled that the Secretary for Mines recently broadcast an appeal for an increase of 10 per cent. to 15 per cent. in the outputs of the various districts, so that stocks could be laid down during the coming months as a reserve for next winter. It was expected that the demand from domestic users would decrease shortly with the coming of warmer weather, and that the coal released, with the extra coal raised as a result of the present drive, would enable adequate stocks to be accumulated. Every effort has been made to ensure that production does not suffer through any lack of transport and it was understood that better plans for distribution had been devised which would obviate as far as possible unduly long hauls on the railways. In addition, it was stated that little difficulty would be encountered in getting the coal away from the collieries during the coming summer, when the longer hours of daylight would enable loading to be expedited. Export business was still curtailed on the steam-coal market. Most collieries engaged in this section were well supplied with orders, but deliveries under existing contracts were in arrears. Consequently, were it not for the home trade, which was very actively maintained, the collieries would be faced with a serious situation. As it was, it was feared that harm might be done to the export trade of the district, since the difficulty of operators in supplying might cause customers to make purchases elsewhere. The matter was again engaging the attention of the various bodies affected who were keeping the position constantly before the Government departments concerned. Bituminous coals were in sustained request from the inland section, and the occasional odd lots coming on the market could usually be disposed of at firm figures. Dry steams continued to find a steady outlet in the Ely-cann trade and the tone was consequently steady. The present outputs of best large sorts were being almost entirely absorbed by deliveries on account of existing contracts, while the sized grades remained scarce and strong. Bituminous smalls were also only sparingly available for a long time ahead, but inferior smalls were plentiful and dull. Cokes remained active, but patent fuel was quiet.

The Iron and Steel Trade.—The iron and steel and allied trades were very busy during the past week. Works, generally, were operating at full capacity, and efforts were being made to expand production still further in order to meet the insistent demand for the various finished products.

THE LATE SIR NIGEL GRESLEY, C.B.E.: ERRATUM.—On page 315, *ante*, in our obituary notice of Sir Nigel Gresley, the late chief mechanical engineer of the London and North Eastern Railway, it was stated inadvertently that the experimental 4-6-4 locomotive, No. 10,000, was eventually rebuilt with a boiler of the "Green Arrow" type. Actually, the type of boiler was that fitted in the "Cock o' the North" class, with a grate area of 50 sq. ft., as against the 41·25 sq. ft. of the "Green Arrow." This was made clear in our account of the conversion, on page 682 of our 144th volume, from which the note was incorrectly transcribed.

THE LATE PROFESSOR C. G. CULLIS.—We note with regret the death of Professor Charles Gilbert Cullis, D.Sc., which occurred suddenly at Hindhead, Surrey, on April 27. Dr. Cullis, who was Emeritus Professor of Mining Geology, University of London, Royal School of Mines, Imperial College of Science and Technology, South Kensington, was the youngest son of Mr. F. J. Cullis and was born at Gloucester, in 1871. He was educated at King Edward VI Grammar School, and Mason College, Birmingham, and afterwards became a student of geology at the Royal College of Science, London. He gained the Murchison Medal in 1891 and in the following year was appointed demonstrator in geology at the College. Subsequently he became Assistant Professor of Geology and Mineralogy at the Royal College of Science and continued in this capacity until 1914, when he was appointed Professor of Economic Mineralogy in the Imperial College of Science and Technology. In 1930, he was made Professor of Mining Geology at the Royal School of Mines and occupied this position until his retirement, and appointment as Emeritus Professor, in 1937. Professor Cullis, who was for many years a member and was a Past-President of the Institution of Mining and Metallurgy, was serving as a member of the Non-Ferrous Metallic Ores Committee of the Ministry of Supply. In 1919, he drew up a report on the world's production of silver for the Indian Currency Committee. He was also the author of a report on the copper deposits of Cyprus, prepared at the request of the Colonial Office in 1922. Two years later he published a work entitled *Geology and Mineral Resources of Cyprus.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Active conditions continue in the Scottish steel trade and the exceptionally heavy demands for material for the many and varied requirements of the Government are being met regularly, but there is very little steel available for general commercial purposes. The demand is not confined to heavy steel, as light plates and sections are in request. In the black steel-sheet trade a pressing demand exists for deliveries against contract and both plain and galvanised sheets are required for Government work. The output of the steel industry has improved considerably in recent months. Supplies of raw materials have been satisfactory, and as deliveries of steel scrap have greatly improved, production will continue on a high level. The following are the present quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black steel-sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—The recent improvement in the malleable-iron trade of the West of Scotland is well maintained. The supply of wrought-iron scrap has improved and the outlook is satisfactory. Although the re-rollers of steel bars are still fairly busy, little change is reported in the amount of new business and a number of firms are now able to give prompt delivery. Good supplies of semies are now in hand. The current quotations are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—No change has taken place in the Scottish pig-iron trade during the week and all the blast-furnaces are operating at full capacity. The demand from steelmakers continues to be very heavy and the full production of hematite and basic iron is going rapidly into consumption. The recent improvement in the demand for foundry iron continues, and that grade of iron is moving fairly freely. To-day's market quotations are as follows:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—By working at maximum capacity, Sheffield's greatly extended plants are successfully meeting the present heavy demands. Many firms have a waiting list of orders, but no serious delay is likely to occur in carrying out the work. Raw and semi-finished materials are coming forward in ample quantities. Steelmakers are satisfied with the way in which producers of pig iron and hematites are meeting the situation. Scrap dealers are also keeping their customers well supplied. In the heavy machinery and engineering trades the position has undergone no material change. Rolling mills, forges, and foundries are operating at full capacity, and re-rollers are fully employed; record outputs are being accounted for by strip and bar mills. There is a heavy demand from all parts of the country for rods for concrete reinforcement. Structural steel is also in demand, and producers are having some difficulty in keeping pace with all requirements. Mining enterprises in the South Yorkshire coalfield are using more steel arches and girders for roof support. Progress is also reported in the production of cold-rolled strip, cold-drawn bars, polished steel wire, light forgings and castings, and tubing. Works specialising in the production of hollow-forged high-pressure vessels have numerous orders on hand. Large forgings are being turned out for chemical plant and boiler drums for power-station extensions in various parts of the country. Mining plant is a progressive line; steel tubs are being used in larger numbers by collieries all over the country, and there is a better demand for coal-cutting machines, pneumatic drills, conveyor equipment, screening plant, and washers. Machinery for the production of cement is active on both home and overseas account, and the market in quarrying equipment has been well maintained. Firms supplying shipyards are turning out a large assortment of machinery and tools. In addition, there is a strong demand for turbine parts, boilers, and also deck furnishings for ships now on the stocks. Railway rolling stock shows improvement; wheels, axles, springs, tyres, and buffers are all in better request.

South Yorkshire Coal Trade.—The inland trade has been well maintained, but exports are very restricted and show little sign of improvement. Industrial concerns in this area are consuming large tonnages of coal. Steams are an excellent market, and smalls and slacks are also in good demand. Locomotive coal is moving in larger quantities. The house coal market is in a better position than usual at this time of the year.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North-Midland Centre:* Saturday, May 3, 2.30 p.m., The Brotherton Library, The University, Leeds. Annual General Meeting. Address by Dr. R. Offor. *Institution:* Thursday, May 8, 2.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting. The Thirty-Second Kelvin Lecture: "Electrical Works by Helios, or the Sun and the Ionosphere," by Dr. S. Chapman. 3.45 p.m., Annual General Meeting.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Almost the whole of the iron and steel production is now needed for purposes associated with the prosecution of the war, so that little is available for ordinary commercial business. The tonnage produced is passing promptly into use and the large and increasing supply of materials from the United States is taken up as it can be delivered. By careful distribution of the available tonnage, however, the congestion of orders at the works has been relieved, and delivery periods are being reduced.

Cleveland Iron Trade.—The tonnage of Cleveland pig at the disposal of sellers is small and any expansion of the present output is unlikely, but consumers of foundry iron are still able to obtain ample supplies from other producing areas. The increasing requirements of North East Coast consumers are satisfactorily covered by the supply of Midland brands. The recognised market values of Cleveland pig are ruled by No. 3 description at 128*s.*, delivered within the Tees-side zone.

Hematite.—There is still some difficulty regarding the supply of hematite, but there are indications of an early change for the better. While the make is restricted, the imports of American hematite are expected to increase considerably. Meanwhile, the tonnage available for distribution has to be allocated carefully to ensure adequate deliveries for essential purposes. Licences for supplies are granted only to consumers engaged on work for which all substitutes for hematite iron are unsuitable. The stabilised quotations remain at the level of No. 1 grade of hematite at 138*s.* 6*d.*, delivered to North of England areas.

Basic Iron.—The output of basic iron is quite adequate for the heavy needs of the makers' own steelworks and occasionally provides a small surplus tonnage. There are no saleable parcels and the price remains nominal at 120*s.* 6*d.*

Foreign Ore.—Foreign ores are in good supply, with the exception of descriptions needed for the production of hematite. The extensive use of native ironstone has greatly reduced the dependence on tonnage from abroad.

Blast-Furnace Coke.—Holders of Durham blast-furnace coke are in a position to offer large parcels, but are well sold and are not inclined to make further contracts until they have reduced their delivery commitments considerably. As local consumers are extensively covered, business is quiet. The fixed prices are based on good medium qualities at 35*s.* 6*d.* f.o.r.

Manufactured Iron and Steel.—The substantial quantities of semi-finished iron and steel in hand at the consumers' works and satisfactory deliveries coming forward are sufficient to ensure great activity at the re-rolling plants. The tonnage output of finished products is large and manufacturers of several commodities are unable to accept further orders until they have reduced their contract commitments. The demand for heavy constructional steel, however, is rather easy, so that producers can pay more attention to specifications for other materials; priority delivery is accorded to shipbuilding requisites. Black and galvanised sheets are still in urgent demand and there is increasing pressure for the supply of special alloy steels. Soft steel billets are quoted at 12*l.* 5*s.*; hard billets at 13*l.* 12*s.* 6*d.*; joists and sections at 15*l.* 8*s.*; heavy ship plates at 16*l.* 3*s.*; and heavy rails at 14*l.* 10*s.* 6*d.*

Scrap.—The delivery of iron and steel scrap is exceptionally heavy, but more is still required, particularly of heavy grades of material.

INSTITUTION OF ELECTRICAL ENGINEERS.—Copies of the annual report of the Council of the Institution of Electrical Engineers, for the session 1940-41, and of the accounts for the year ended December 31, 1940, both of which are to be presented at the annual general meeting on Thursday, May 8, at 3.45 p.m., can now be obtained by members of the Institution on application to the Secretary, Savoy-place, London, W.C.2.

THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

(*For Description, see page 341.*)

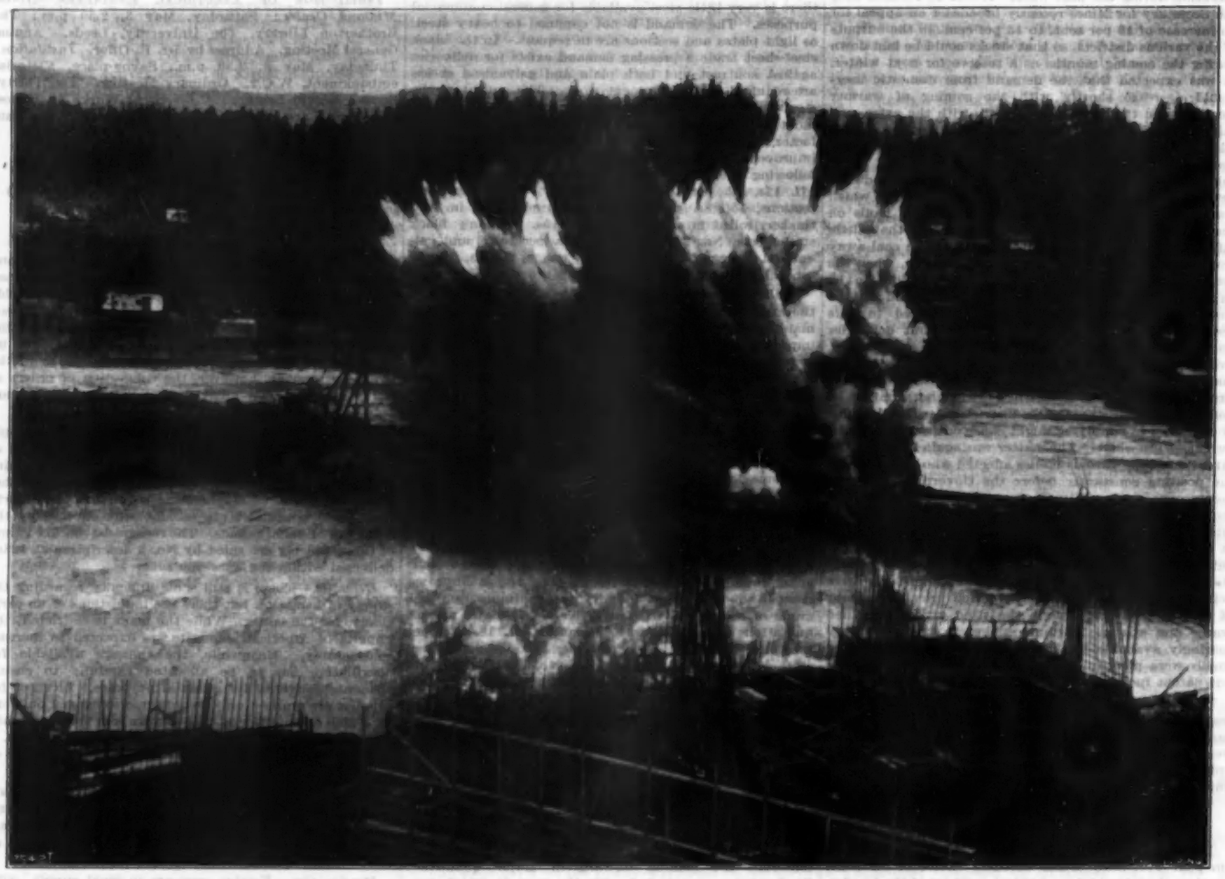
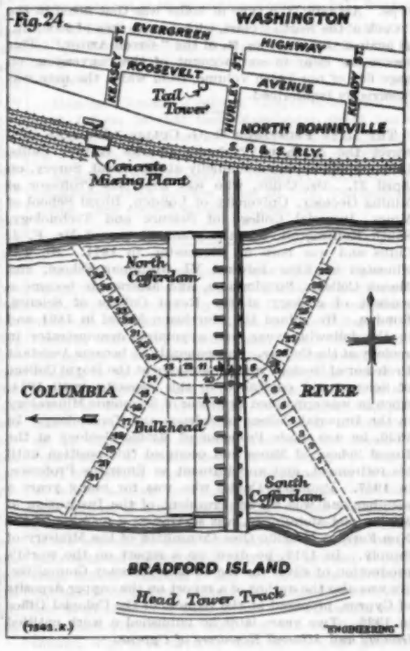


FIG. 22. REMOVING CRIB OF SOUTH COFFERDAM BY BLASTING.

FIG. 23. PLACING CLOSING CRIB IN UPSTREAM ARM OF NORTH COFFERDAM.



COAL STOCKS AT GENERATING STATIONS.—The Electricity Commissioners have been asked by the Mines Department to bring to the notice of electricity undertakings owning generating stations that coal which has been held in stock for a number of years may have deteriorated in quality. It is, therefore, suggested that the opportunity should be taken of consuming any stocks of old and low quality coal with the object of preventing further deterioration and also clearing the site for the reception of new stocks.

ENGINEERING.

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London W.C.2.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS { "ENGINEERING," LESQUARE, LONDON.

TELEPHONE NUMBER—TEMPLE BAR 3663 (2 lines).

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months (or for six or three months, *pro rata*), payable in advance :—

For the United Kingdom	£3	5	0
For Canada—			
Thin paper copies	£2	18	6
Thick paper copies	£3	3	0
For all other places abroad—			
Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of Publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

CONTENTS.

	PAGE
The Bonneville Dam on the Columbia River, Oregon, U.S.A. (*Illus.*)	341
Literature.—Canning Practice and Control	344
Reproducible Flame for Testing Electrical Insulating Materials	345
Notes on New Books	345
Universal Tool-Grinding Machine (*Illus.*)	346
Reciprocating Hand Pump (*Illus.*)	347
Books Received	348
British Standard Specifications	348
Personal	348
Notes from the South-West	349
Notes from the North	349
Notes from South Yorkshire	349
Notices of Meetings	349
Notes from Cleveland and the Northern Counties	349
Supervision	351
Welding and the War Effort	352
Notes	353
The Physical Condition of the Planets (*Illus.*)	354
Letters to the Editor.—Calculation of Terminal Velocities. Tool Dynamometer for Measuring Rapid Force Fluctuations. The Vacustat. The Efficiencies of the Centrifugal Pump	355
The Brush Surface Analyser	356
The University and Industry	356
3-Cub. Ft. Vacuum Pump and Air Compressor (*Illus.*)	357
Draft Specification for External Measuring Comparators	358
Labour Notes	358
Effect of Prolonged Heating at 80 Deg. C. on Copper Wire	359
"ENGINEERING" Patent Record (*Illus.*)	360

Two One-Page Plates.—THE BONNEVILLE DAM ON THE COLUMBIA RIVER, OREGON, U.S.A.

ENGINEERING

FRIDAY, MAY 2, 1941.

VOL. 151. No. 3929.

SUPERVISION.

NEARLY 70 years ago, we devoted a leading article to some comments on the meetings of the Institution of Mechanical Engineers, in which it was suggested that the Institution had achieved such a status in the world of mechanical engineering that it should consider seriously whether the subjects discussed at its meetings should not be more critically selected, with a view to interesting a larger proportion of the membership. We were quite ready to admit (we declared) that almost without exception the communications made to the Institution were prepared with care, while they were also, in many instances, undoubtedly of great value ; but we submitted that far too many of them related to subjects of merely personal interest.

On some more recent occasions we have heard similar observations made, at meetings of this and of other institutions, when some abstruse and highly particularised paper has been under discussion, on some subject that was definitely "caviare to the general" ; indeed, before the war, it seemed as though the practice of institution reading committees was tending, in all directions, towards the exclusion of any paper that did not demand the experience of a specialist in anyone who might presume to speak upon it. For this reason, we must congratulate the Institution of Mechanical Engineers on the successful break with tradition represented by the meeting held on Friday last, April 25, when Mr. G. E. Windeler (member of Council) initiated a discussion on "Mechanical Mishaps." Originally, it is understood, this was intended to be an "informal" meeting, and as such, of course, could not be reported. In fact, it developed into more or less of a "formal" occasion, with the President in the chair, with the secretary at his side, and a full row of members of Council in their accustomed places ; but with the accompaniments of a degree of informality which was almost that of an "informal" meeting, and a subject to which, had time permitted and inclination urged, probably every member present could have contributed something of interest from the store of his own experience.

There is no occasion to deal in detail with all the instances that Mr. Windeler cited : the splined shaft from which he removed the splines with his fingers ; the shaft which broke because an oil hole was incorrectly drilled ; the coupling on a Diesel-engined locomotive, which shed a bolt or two almost daily ; the bent stainless-steel valve which some eager mechanic had tried to straighten by heating and hammering it ; the roller-bearing which failed because the top of a fabricated bedplate had been made of plate only ¾ in. thick, which vibrated excessively ; and a number of others, all interesting and most of them, as he had proved, capable of being cured fairly simply by the exercise of a little of that "gumption" which is so invaluable an attribute in an engineer. More important than these isolated instances, however, were the general conclusions to be drawn from them ; more especially the point, mentioned in the discussion, that nine-tenths of these so-called "mechanical mishaps" would not have occurred at all, had there been adequate supervision at each stage of the design, construction and operation of the machinery concerned.

It has been said that the only real difference between the skilled tradesman and the amateur mechanic is one of time ; that, given the tools and the perseverance, the amateur can do practically everything that the skilled man can do, provided only that time is not taken into account. Like so many generalisations, this is only half true. Skill is much more than a mere question of manual dexterity or even of "knowing how," and every advance in the application of science to constructional purposes widens the gap between the skill of to-day and that which characterised the craftsman of half a century ago. There is another respect, however, in which the craftsman of former years differed from the average skilled mechanic of to-day, and that lies in this very question of supervision. Modern works management has made of supervision almost a separate industry, but there is some reason to suspect that, in some directions, this high degree of specialisation tends to defeat its own object. The more elaborate the organisation of inspection, the more the individual is encouraged to rely upon it and to reduce his own share in the production to a semi-automatic routine. So long as the repetition of a succession of operations is all that is required, this method may suffice ; but as the operator becomes set in a routine habit of mind, there is increasing danger that he may fail to observe or to report some small incident or defect which may prove to be crucial, when the part concerned has been some time in service.

The weakness of the modern system of production is that inspection itself tends to become a matter of routine. Where the production is in large quantities, this is inevitable, and every effort is made to encourage the tendency by reducing it to a succession of simple operations, each carried out with the aid of single-purpose gauges or other tools which make little demand upon the intelligence of the inspector. In such a case, of course, the effect is to put back to an earlier stage in production the point at which the exercise of individual "gumption" reaches a critical value. Instead of the user of the gauge or other testing appliance having to employ special skill in its application, it is for the designer and maker of the instrument to see that it cannot be misapplied or its readings misinterpreted ; but the draughtsman and the toolmaker must still be supervised to some extent. Ultimately, therefore, the individual responsibility for ensuring satisfactory performance is divided between the originator of the product and the operator of it ; exactly as was the case in the earlier days of engineering, when the individual craftsman was his own most critical supervisor and the operator expected, as a matter of course, that he would have to carry out a considerable amount of intelligent maintenance work on his own responsibility, without reference to the builder of the machine.

The elaborate subdivision of supervisory functions is unavoidable in mass production, and, quite evidently, works with reasonable efficiency as a general rule ; though it does not obviate the disadvantage that a shortcoming in design, of a kind that can only be detected in service, may be costly to correct, out of all proportion to its relative

magnitude as a feature of the complete assembly. It is still the case, however, that the majority of engineering work is not mass-produced; a great deal of it is not even batch-produced, but represents single orders, either entirely original in character or so modified from a so-called "standard" pattern, to meet the special needs of the purchaser, as virtually to rank as a separate design. Probably a majority of the instances cited by Mr. Windeler came into this category, and it is on such work that the importance of adequate supervision, as distinct from mere inspection, becomes most significant.

The ideal solution, of course, is for designer, constructor and operator to be fully acquainted with all the relevant facts and circumstances and to be, individually, fully competent to deal with them, but this is obviously too much to expect. To take one only of Mr. Windeler's examples: for the mechanic who botched the repair of the stainless-steel valve, somewhere in the Middle East, to have made a proper job of it, he must first know (*a*) that the value in question was of stainless steel, and (*b*) that the reaction of stainless steel to heating and hammering was not the same as that of the valve steels of which, presumably, he had some previous experience. The man engaged in manufacture has some opportunity to keep himself informed of such developments; the man "on site," more commonly, has not. It is easy to say, after the event, that the manufacturer should have foreseen such a contingency and should have warned the user to maintain sufficient spares to avoid the need to attempt emergency repairs; but the manufacturer cannot foresee every contretemps that may arise in service, especially service in some remote country, and if he could, and provided against it in his operating instructions, the list of warnings would probably attain such a length as to suggest, quite unreasonably, that the machine in question was not suitable for the conditions. The only remedy in a case of this kind appears to be a higher standard of supervision on the site.

So far as concerns supervision in the stages of design and construction, however, the whole question appears to be intimately bound up with that other problem raised by Mr. W. A. Woodeson in his presidential address to the North-East Coast Institution of Engineers and Shipbuilders,* namely, what is the maximum size of an efficient engineering organisation? It will be recalled that his own suggestion was that the highest efficiency was obtained when the concern was no bigger than could be adequately controlled by a single person. Beyond that expression of opinion, he did not pursue the topic; and, as presidential addresses, as a rule, are not open to discussion, there was no opportunity to debate the interesting point of the optimum size of works and number of its personnel that this tentative standard represents. We have canvassed a few typical individual views on the matter, and the general opinion appears to be that a total of 200 employees, all told, is about the maximum, though it must be evident that a great deal will depend upon the nature of the manufacture being carried on. If the establishment is devoted solely to the production of some narrowly specialised article, it should be more practicable for one man to retain a close control over every phase of its design and construction than would be the case in a general engineering firm which is prepared to undertake anything within the physical capacity of its plant. This is a subject which may have a direct bearing on the future organisation of the engineering industry, and we should like to hear it discussed at some such quasi-informal meeting of the Institution of Mechanical Engineers as that addressed by Mr. Windeler. The tendency towards large industrial combinations is not likely to be retarded as a result of the war, and for many purposes such combinations must continue to be essential; but there will still remain a wide field for the less pretentious undertakings. The supremacy so long enjoyed by British manufacturing industry, it should not be forgotten, has been built up by individual effort and individual attention to the consumer's needs; and it is upon the skill and care of individuals that the future prosperity of the industry must depend.

* See ENGINEERING, vol. 150, page 345 (1940).

WELDING AND THE WAR EFFORT.

WAR, as history shows, has a stimulating effect on many other forms of human activity. It is this result which provides the answer to those who argue that hostilities between nations could be prevented by forbidding the production of certain materials or by placing an embargo on certain activities, especially in the field of engineering. During the war of 1914-18, the investigations that were conducted, regardless of expense, into the design of aircraft; and the advances that were achieved in the various methods of radio communication, had the effect of short-circuiting what would otherwise have been a long period of slow development, with results which, it must be admitted, have not been without benefit to the human race. As in sociology, so in engineering, responsibilities are willingly shouldered in war time and risks are taken which would only be assumed with difficulty in peace, when other values than a vital struggle for existence exert a preponderating influence.

The latest example of this was interestingly illustrated by Dr. H. J. Gough, F.R.S., Director of Scientific Research at the Ministry of Supply, in a speech which he made at the luncheon of the Institute of Welding, held in London on Wednesday, April 23. Social functions, like other things, have suffered changes under present conditions, and the importance of what he had to say was ample justification for a departure from the excellent rule that post-prandial speeches should not be burdened with matter that imposes too much strain on the intelligence. In his opening remarks, Dr. Gough recalled the Symposium on Welding which was held six years ago. As a result of this meeting, the engineering societies agreed that the formidable and responsible task of organising and co-ordinating research in welding should be undertaken by the Institute. In the period that has elapsed since that date much useful work has been done. For instance, an extensive research into the weldability of high-tensile steels has enabled practical rules for the welding of these materials to be prepared, a medium high-tensile steel of good weldability has been developed, and progress has been made with the production of weldable steels of higher strength. Further, much knowledge has been gained of the factors involved in the welding of non-ferrous metals and in particular of the nature and behaviour of fluxes; while a study of the strength and consistency of spot welds in light aluminium alloys leads to the hope that this form of connection will be successfully extended to aircraft production, so important at the present time. Of equal importance are the investigations that have been made into the strength of welded-ship structures, and the researches on the butt welding of tubes for high-pressure steam piping, especially as so many factories are now being equipped with that service.

Welding, however, not only plays its part in the production of war material, but can also be used to counteract the enemy's efforts to destroy existing structures. The war in the air must be fought passively as well as actively. For that reason, Dr. Gough did well to mention a branch of research which does not appear to have received the official attention that its present importance warrants. This research comprises investigations into the strength and behaviour of steel frameworks with rigid joints. It has now been shown that the load-carrying capacity of such rigid steel frames exceeds that of a similar structure with flexible joints by as much as 30 per cent. This fact would, of course, be important at any time, since it would enable a corresponding saving to be achieved in the amount of steel consumed; in time of war, however, it is especially significant that such a rigid frame, or even one possessing continuity in the framework, will resist the effects of blast when a structure built to ordinary designs will collapse. We understand that the information gained in this investigation has already been made use of in the design of shelters and protective structures. It is a matter of regret, however, that its application has not been extended; and that no active steps have yet been taken to ensure that factories shall be given that measure of extra security which could be obtained by welding-on connecting straps and thus making the structure continuous. This addition could be effected at a small expenditure of labour and material, and would be worth while as an investment, where valuable buildings and plant are concerned.

As Dr. Gough observed, these typical examples of what is being done to develop the science and art of welding are a tribute to the value of the research work carried out by the Institute. They should also serve as an incentive to further progress on the same and new lines, in order that the best use shall be made of this simple and flexible process. This statement may be supported by considering some of the more general aspects of welded fabrication. At present, there are about 150,000 welders available in this country, yet only 15 per cent. of the work that could be satisfactorily and economically welded is being carried out by that means. It does appear, therefore, that, at the present time, when increased production of war material is such an urgent need, it is the plain duty of all concerned to examine most carefully whether greater use cannot be made of fabricated construction. It would be foolish, of course, to urge welding simply for welding's sake; the pros and cons of the change in practice must be weighed in the light of the particular circumstances. There seems no doubt, however, that welding could be employed to a much greater extent, and the process has the further advantage that the necessary operatives can be easily trained.

In support of this argument, Dr. Gough instanced the use of welding in the construction of portable hangars, military bridging equipment, light armoured cars, and of bombs and shells, in the endeavour to save weight. By the employment of welding instead of riveting in the construction of an anti-aircraft gun platform, for example, there had been a saving of 19 per cent. in weight and of 63 per cent. in man-hours. A similar change-over for a field-carriage assembly reduced the production cost per unit from 269*l.* to 60*l.* This was mostly due to a saving in machining time. The aggregate saving was over 2,000,000*l.*, a figure of which even a Chancellor of the Exchequer might take cognisance. While these examples relate to actual achievements, there are several important developments which are worthy of close consideration. It has been shown, for instance, that a saving of weight of as much as 20 per cent. can be effected by using fabricated construction in shipbuilding. It is estimated that about 50 per cent. of the whole output of welding materials is already being used for this purpose, but it is obviously worth while to consider whether this figure could not be improved. Even more interesting are the advances in technique which have made practicable the welding of armour plate for fighting vehicles, as this will lead to a reduction in deadweight which can either be saved or employed for other purposes. Generally speaking, too, it is worth while making special efforts, by the more extended use of welding, to relieve the machining capacity of the country and equally the load imposed on the drop-stamping machines and foundries. As is well known, substantial economies can often be effected by welding together a number of component parts of suitable design to form a complete unit.

It is satisfactory to learn that the desirability of investigating the possibilities of welding as a factor in the war effort has been recognised by the Ministry of Supply. The problem is not without its complications, and an Advisory Service on welding, staffed by specialists in the different aspects of the practice has therefore been set up. This body advises on the designs necessary to ensure that the fullest advantage is taken of welding in reducing weight, securing economy of material and labour, and increased production. It also advises production departments on welding equipment and technique, and inspection departments on the methods of inspecting welding work to ensure the maintenance of the necessary standards of quality and performance. We are not surprised to learn it is already producing excellent results. This is a firm of co-operative effort which deserves and will undoubtedly receive its due reward.

NOTES.

Engineering Advisory Committee.

The Lord President of the Council, with the approval of the Prime Minister, has appointed an Engineering Advisory Committee to advise the Government upon engineering questions connected with the war effort. In particular, this committee will consider how the resources of the engineering profession can best be utilised in connection with the war work of Government departments and to nominate engineers who might suitably be invited to undertake particular tasks. They will also be invited to advise on problems referred to them in connection with the development of new engineering devices and on methods of bringing such devices speedily into production and on means of meeting new war requirements in the engineering field. Finally, it will be their duty to examine new ideas or devices in engineering likely to assist the war effort, to test their technical validity and to bring to the notice of the Government those which appear to merit further consideration by the department concerned. The committee will consist of Lord Hankey, Chancellor of the Duchy of Lancaster, as chairman, and Lord Falmouth, M.I.Mech.E., as vice-chairman. The members will be Sir Henry Tizard, F.R.S., and the following, who have been selected after consultation with the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers:—Mr. J. R. Beard, M.Inst.C.E., M.I.E.E., Dr. A. P. M. Fleming, M.I.Mech.E., M.I.E.E., Mr. W. T. Halcrow, M.Inst.C.E., Mr. B. W. Holman, M.Inst.Chem.E., Dr. C. C. Paterson, M.I.E.E., Mr. H. R. Ricardo, F.R.S., and Principal A. Robertson, F.R.S. Representatives of the Government research establishments and production departments will be associated with the committee as required from time to time.

Women in Engineering Industry.

After a certain amount of initial delay, the employment of women on engineering work is now assuming considerable proportions; and a summary of typical processes on which they are engaged, recently compiled by the Ministry of Labour and National Service, shows that, with proper training, many of them are capable of undertaking much more skilled operations than the mere minding of automatic or semi-automatic machines. The majority of course, are employed on work of a more or less repetition character, particularly on capstan lathes, milling and drilling machines, and on inspection and light assembly work; but one firm is employing women to operate Heald internal grinders, on which aero-engine sleeve valves are ground to a tolerance of 0·0002 in., and on thread-grinding machines working to similar limits. On airframe construction, women are carrying out the pneumatic riveting of main spars and the welding of steel and aluminium, many of them holding A.I.D. test certificates as approved welders of stressed parts. In another works, women are welding fabricated structures in steel plate of thicknesses ranging from ¼ in. to 1½ in. The employment of women on most processes in the manufacture of shells and fuses is very common, but mention may be made of one firm in Yorkshire where women, under a woman supervisor and a forewoman, are carrying out all the operations involved in the production of 25-lb. shells, except that of roughing; and in one of the Royal Ordnance factories they are operating boring lathes for long 6-in. gun barrels. Another firm employs women to mill gun parts to limits of 0·001 in., and on grinding to 0·0001 in., on Brown and Sharpe machines. Women were engaged in instrument making to a certain extent before the war, and are now being employed in much larger numbers on work of this kind, such as optical grinding and polishing. In one works in this category they are engaged on general machine-shop operations, and, after three months' experience, proved capable of working to drawings and of doing their own setting up. Another instrument maker, in London, employs women on grinding (including pivoting) and gear hobbing on Mikron machines, checking the tooth profiles by optical comparators and, in some cases, making their own adjustments when the profile is incorrect. A firm engaged on tool and gauge making is employing women on capstan setting, internal and external grinding, and the grinding of screw gauges, and is training one woman in jig boring. A West Riding firm of machine-tool makers has women operating small surfacing and boring lathes, Sunderland gear planers, Fellows gear shapers, Churchill grinders, Hey tooth rounders, Defries key seaters, and Pratt and Whitney duplex spline millers. Two Birmingham firms have women works managers, who are also capable of press-tool setting; and a locomotive firm, now engaged on general engineering work, has 250 women doing non-repetitive work, including the operation of planing machines (for which they do their own tool grinding) and slotting machines, and of 6 ft. 6 in. radial drilling machines, on which they do their own setting up and use no jigs.

The Institute of Welding.

War has inevitably reduced the number of social gatherings in which the various technical bodies were wont to indulge during the winter months. A few have abandoned such functions altogether, while an increasing number are substituting luncheons for the customary dinners. Among the latter is the Institute of Welding, which held a successful luncheon at Grosvenor House, London, on April 23, 1941, under the presidency of Sir William J. Larke, K.B.E. One of the advantages of this arrangement to many of the participants is that it necessarily abbreviates the length of the toast list; everyone, nowadays, is fully occupied—the principal guests, probably, more than most. On this occasion, there were only two speeches, one by the President in proposing the toast of "The Guests," and the other by Dr. H. J. Gough, M.B.E., F.R.S., in reply. The latter was less a speech than an interesting lecture on the rôle of welding in the national war economy, and forms the subject of the leading article on the opposite page. Sir William Larke, in proposing the toast, said they all knew the great results that had been obtained by the use of welding; in fact, a saving of 75 per cent., both in time and material, was not unusual. At the present juncture, time was even more important than material, and if that could be saved by the greater extension of welding, any effort in that direction would be well worth while. There was still a good deal to be done, however, especially in the design departments, to make welding more effective, and the resources of science and technology must, therefore, be vigorously applied. He was glad to say that the research work of the Institute was going on as in peace time, though it was being influenced by the needs of the Services; and it was receiving increasing support from industry, as was shown by the fact that, during the past year, their membership had increased by 20 per cent.

Access to Foreign Periodicals.

Serious workers in all branches of science and technology find it desirable to keep in touch as far as possible with foreign periodicals covering their special field of work. This is particularly necessary for research organisations of all kinds. Many users of such journals consult them indirectly through the abstracts which are published by various bodies, but this work has been seriously interfered with by the war. A questionnaire circulated to certain of its members by the Association of Special Libraries and Information Bureaux, in August, 1940, showed that the supply of scientific and technical periodicals from Germany, Italy and the countries under their domination had almost ceased after the issues of May, 1940. In recent months there has been some improvement, and the Association is putting forward proposals designed to facilitate the best use of the supplies, still meagre, which are now being received. The proposals cover journals published in Germany, Italy, France, Belgium, Denmark and the Netherlands. As, under the Trading with the Enemy Act, the import of essential matter only is permissible, in general only one copy of each issue of any periodical is reaching this country. The greater part of the supply is passing to Government libraries; of these, the Patent Office library and the Science Museum library are open to the public. A Union List of the periodicals being received by Government libraries is being issued monthly by the Stationery Office for inter-departmental use, and, as a copy of this List is sent to Aslib, that Association is in a position to inform its members if any particular periodical is available in one or other of the open Government libraries. The present proposals of Aslib are that the Union List should be supplemented by the addition of the names of periodicals reaching its member libraries; that contents lists of the periodicals should be included; and that a system of circulation and exchange should be introduced with, if possible, the use of photographic copying for valuable articles, so that they may reach a wider circle. A questionnaire has been issued to members of the Association, asking if they would be prepared to co-operate in a scheme of this kind, and subscribe to such an extended Union List or to an elaborated list, including particulars of the contents of the journals. It will be clear that these useful proposals involve some difficulties, especially in connection with the preparation of photographic copies of articles. Most special libraries have no facilities for carrying out work of this kind, and it will be necessary for Aslib to act as a clearing-house and make arrangements with some photographic agents. With the circular giving particulars of these proposals there is included a list of journals known to have been received from enemy, or enemy-occupied, countries in February, 1941, and it is of interest to note that, while it contains the names of 104 German publications and seven Italian, there is only one from France (Lyons) and none from any of the other occupied countries. This suggests that, in territories under their domination, the German authorities are suppressing all technical publications, which, presumably, they are hardly in a position to control directly in the manner that they adopt with daily newspapers.

The Institution of Structural Engineers.

Speaking at a luncheon given by the Institution of Structural Engineers at the Dorchester Hotel on Friday, April 25, the Rt. Hon. Arthur Greenwood, P.C., M.P., Minister without Portfolio, briefly surveyed the progress of the war, pointing out that, while we had inflicted grave injuries on the enemy, more production was necessary to supply the Forces with the equipment needed for successful attack. He had no doubt that we should pass through the dark days ahead of us, not unscathed but unbowed, and with the certainty that victory would crown our efforts. We must think, however, of the world after the war, but must not raise illusory hopes that could not be fulfilled. The profession of structural engineering had its part to play in the work of reconstruction. Buildings we had revered had been destroyed, but we had men who were capable of rebuilding them. This work was partly his responsibility, but he was anxious to embody in it the experience and goodwill of structural engineers. Mr. Greenwood's remarks were made in proposing the toast of "The Institution of Structural Engineers," coupled with the name of the President, Mr. J. F. Butler, A.M.Inst.C.E., who occupied the chair. In responding, Mr. Butler remarked that some people seemed to think that because of the war everything must be reconstructed, but there was no reason why their views should not have been expressed at any time during the past twenty years. The connection between reconstruction and the war was that employment must be provided for the men who returned to civil life after serving with the Forces. Many of these men would be employed on building and public works, but their employment must follow organised lines. Restrictive legislation was not wanted, but national planning should follow only broad lines. Mr. Greenwood could rely on any help the Institution could give him in his work. The only other toast, that of "The Guests," was proposed by the president-elect, Mr. W. K. Wallace, M.Inst.C.E., and the response was made by Mr. George Hicks, M.P., Parliamentary Secretary, Ministry of Works and Buildings.

The Junior Institution of Engineers.

The annual luncheon of the Junior Institution of Engineers was held at the Holborn Restaurant, London, W.C.2, on Saturday, April 26, the chair being taken by the President, Lord Falmouth, who was supported by Sir William Bragg, O.M. (vice-

president) and Sir Charles Bressey, Sir Leonard Pearce and Mr. W. A. Tookey (past-presidents). Sir Leopold Savile, president of the Institution of Civil Engineers, in proposing the toast of "The Institution," to which Mr. J. W. Stenson responded, endorsed the admiration expressed a year ago by his predecessor in office, Sir Clement Hindley, for the manner in which the Junior Institution had adapted itself to the difficult conditions of these times. Sir William Bragg, proposing "Scientific Industrial Research and National Service," took the opportunity to survey the work of scientists in the prosecution of the war. The subject, he pointed out, was quite a modern one; 20 or 30 years ago, no such toast would have been thought of. Its present importance could be gauged from the speech of Lord Hankey in the House of Lords on April 3, when he described the organisation that had been created to co-ordinate the work of "the three great pillars of the permanent civil research organisations of the Government, the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council," all of which were responsible to the Lord President of the Council, who was chairman of the respective committees of the Privy Council, under which they worked. There were now over 30 scientific committees, Sir William continued, including in their personnel some 50 Fellows of the Royal Society; there were 45 committees concerned with the health of the nation; and every Ministry had its appropriate scientific advisers. The aid of science was enlisted as fully as possible in all circumstances, but there still remained much to be done, especially in bringing the scientist into touch with the user of his devices. Research would never slacken; research workers were always facing new tasks. The aim now was to evolve scientists of a new model, who had knowledge of men as well as of materials. What they were trying to achieve was either to make the scientist into a leader, or the leader into a scientist. Lord Falmouth, in replying, said that no man had done more than Sir William Bragg to bring scientific research to the help of the engineer or to make science intelligible. One of the most fruitful disbursements by the Government was its contribution to co-operative research. Sir Harold Hartley, F.R.S., responding to the toast of "Our Guests," declared that the greatest danger in the modern world was the uncontrolled specialist. Mr. J. R. Beard, president of the Institution of Electrical Engineers, who also responded, urged the need that, both during and after the war, civil, mechanical and electrical engineers should be in a position to speak with one voice when the occasion arose.

Control of Building Operations in the Electricity Supply Industry.

Regulation 56A of the Defence (General Regulations), 1939, provides that, generally speaking, the execution in the United Kingdom of "any building or constructional operation" for the carrying on of an undertaking for the supply of electricity shall be unlawful, except in so far as it is authorised by the Electricity Commissioners. This Regulation has now been varied by an Order in Council, the principal changes being as follows:—The limit below which no authorisation is required has been reduced from 500*l.* to 100*l.*, as from April 14, 1941, but work costing less than 500*l.* which was begun before that date may be completed without authorisation. As in the case of private building operations, on which we commented on page 313, *ante*, the costs of works carried out on the same building within twelve months must be aggregated for the purpose of determining whether an authorisation is required. The definition of building or constructional operation is amended so as to make it clear that works required for the purpose of providing water, light, heating or other services are included. The definition, in fact, now covers all alterations and not merely those of a structural character. Power is conferred to enter and inspect land or premises and to ascertain whether any conditions attached to an authorisation have been complied with; and an obligation is placed upon any person engaged in the execution of a building or constructional operation, in respect of which an authorisation has been granted, to produce books and accounts, if required to do so.

THE PHYSICAL CONDITION OF THE PLANETS.

(*Concluded from page* 335.)

Continuing his lecture, Sir James Jeans said that why two such similar bodies as the Earth and Venus should have developed such contrasting atmospheres was an interesting problem. When it was remembered with what avidity oxygen combined with the majority of elements, it was more surprising that our own planet should still retain such a large store of free oxygen than that Venus should retain practically none. Vegetation produced oxygen, but only by utilising water vapour and decomposing carbon dioxide. Vegetation, however, could only exist between narrow limits of temperature and it was conceivable that Venus had always been too hot for vegetation to exist. In such a case, nearly all the free oxygen would be absorbed by oxidation either into the planet's crust or as carbon dioxide. Tamman had pointed out, in 1924, that at the high temperature of the Earth in primitive times, thermal dissociation of water vapour would take place; the hydrogen resulting from this would in time

Fig. 1. JUPITER

Atmospheric Density 0·78
Mean Density 1·34

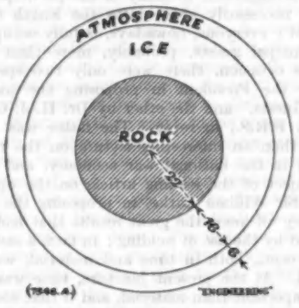
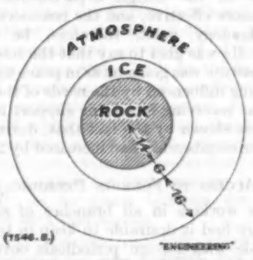


Fig. 2. SATURN

Atmospheric Density 0·41
Mean Density 0·71



escape the Earth's gravitational pull and would be lost, but the oxygen would remain available. If vegetation came into existence as soon as conditions permitted, this store of oxygen would be maintained without oxidation seriously reducing it. It must be assumed that vegetation did not appear on Venus, and that the oxygen produced was ultimately absorbed by oxidation into the cooling crust. Thus it might be that Venus had always been too hot for life, as we knew it, to exist and must always remain so; the thin layer of carbon dioxide in our own atmosphere was known to act as a very efficient blanket. Venus had a thousand times the supply of carbon dioxide and must, therefore, be proportionately more shielded against loss of heat; indeed, estimates of the temperature at the surface of that planet ranged from 80 deg. C. to 130 deg. C.

Wildt, in 1940, urged the more radical possibility that water vapour itself had always been seriously deficient on Venus. In its absence, free oxygen could have been produced neither by thermal dissociation nor by vegetation; insufficient amounts of oxygen and of ozone resulting therefrom would mean that the ultra-violet radiation from the sun would remain unscreened and that, therefore, photo-chemical action would take place extensively in the atmosphere. As carbon dioxide was plentiful, formaldehyde would result in the presence of small amounts of steam. Not only did this polymerise to an icy white solid, but it had been shown by Trantz and Ufer that it combined with a small proportion of water vapour to form a solid polymerised hydrate. Here, then, was a possible explanation of the clouds already referred to as enclosing Venus so completely. We pictured Venus, then, as a planet with an arid surface surrounded by an atmosphere rich in carbon dioxide in which heavy acrid clouds perennially shut out the sun.

Passing beyond the Earth's orbit we reached planets colder than our own. Mars, the next in order, was not greatly so; it received less than half the intensity of radiation falling on the Earth, and actual surface temperatures ranged from + 10 deg. C. on a summer afternoon at the equator to — 70 deg. C. at the poles in winter. Its mass was sufficient to enable it to retain all the gases present in our atmosphere with the exception of hydrogen and helium, and that it had an atmosphere was evident from the photographs taken by W. H. Wright, of Lick Observatory, in both ultra-violet and infra-red light, the former giving a measurably greater diameter. As was well known, ultra-violet rays were scattered by moisture and vapour which infra-red rays could penetrate, so that the latter revealed the solid surface of the planet while the former showed the atmosphere surrounding it. The conclusion drawn from these observations was that the Martian atmosphere was over 50 miles high. Spectroscopic investigation was not very conclusive, but it was difficult to assign to Mars more than one-tenth of the water vapour present in the Earth's atmosphere. The famous polar caps were unlikely to consist of ice to any extent. They were almost certainly an atmospheric phenomenon and probably of similar physical consistency to the clouds of Venus and to our own cirrus clouds. On this hypothesis, they would vary with the seasons, as they were observed to do. Spectroscopic observation showed a lack of oxygen and carbon dioxide, so that vegetation was scarcely possible; but cloud and fog, and to some extent rain, were still possible and the occurrence of these was sufficient to explain the seasonal changes observed by the telescope. The surface of the planet, as stated previously, was apparently very similar to that of the moon and composed of volcanic material. The famous Martian "canals" were still of considerable interest, but their objective reality was now little credited.

Continuing, the lecturer said that Jupiter and Saturn, which were farther from the sun than Mars, were vastly colder. Nothing was known about the solid surface of either, as both had dense atmospheres impenetrable even to infra-red rays. Although much more massive, they were surprisingly less dense than the Earth. Their high rates of rotation would be expected to result in appreciable flattening, but the amount observed was greater than anything that could be explained by rotation alone, and seemed to show that the mass of these planets was very largely concentrated near their centres. (Slides used by Sir James to illustrate the relative distributions of the representative constituents of these planets are reproduced in Figs. 1 and 2.) The low mean densities were explained by the high proportion of atmosphere to the total volume. The values given in the figures, the lecturer explained, followed the calculations of Wildt based on Jeffreys' conclusions; those for the radial distances being in 1,000-mile units. Photographs of these planets showed merely ever-changing appearances such as would be produced by meteorological disturbances. Saturn was the more remarkable in the extent to which its rocky mass was aggregated to the centre, and in that the thickness of the atmosphere was so very much greater than that of the icy material in the intermediate section, a distribution exactly opposite to that of these two zones in Jupiter; this was to be expected from its low mean density.

The enormous masses of the planets resulted in very large integrated pressures of their atmospheres on the surfaces. Under the deep atmosphere of Saturn the pressure was equal to a million times that of the Earth's atmosphere, or more; the corresponding pressure on Jupiter was of the

same order. Under such pressures the gaseous state as we understood it could not exist and the so-called atmospheres must therefore be in the solid or liquid state. The clue to their chemical composition was obtained from the knowledge that only very few substances could retain a density less than that of water when subjected to pressures of the order of a million atmospheres. Apart from hydrogen and helium, the remaining possibilities were the hydrocarbons methane and ethane, and the nitrogen compound ammonia. Spectroscopic observations confirmed the presence of both methane and ammonia; hydrogen and helium were probably present also but since they did not show absorption bands in the visible spectrum this could not be confirmed. In fact, the atmospheres of these planets consisted very largely of highly-condensed methane with a proportion of ammonia.

Uranus and Neptune, still farther away from the sun, were at the temperature of liquid air or even lower. The spectrum of Neptune showed strong absorption bands of methane, but there was no evidence of ammonia; doubtless ammonia at these low temperatures and under high pressure was condensed to lower tensions than were found on Jupiter and Saturn. As for Pluto, the outermost planet of the solar system, this was too small a telescopic speck for present methods of investigation to yield any information regarding its condition.

The lecturer concluded by pointing out that the planets formed, on the whole, an intelligible and regular sequence from the intense heat and aridity of Mercury to the frigidity and tremendously dense atmospheres of the outer planets; but in the series the Earth and Venus occupied an anomalous position since they were larger than their neighbours Mercury and Mars on either side. The Earth was further anomalous in the apparently inexplicably large proportion of free oxygen in its atmosphere. There was nothing anomalous about the physical state of Venus which, apart from its size, fitted well enough into the series. In considering the Earth, it must be assumed that the coming of vegetation had upset the ordinary sequence of physical and chemical change to which otherwise the planet was destined. It was no longer possible, Sir James said, to imagine life as passing inwards from planet to planet as the sun cooled. The most recent knowledge gained of the sub-atomic source of the sun's energy made it clear that the amount of its radiation could not alter substantially while the supply of atomic material for transformation was kept up. Life, therefore, was not a recent immigrant from Mars with the expectation in a short time, astronomically speaking, of being exiled from its present home and forced to take up its abode on Venus. The Earth, because it was the only planet of the system with a temperature range suitable for life as we knew it, was the unique planet of life and, to the best of our knowledge, always had been and always would be.

LETTERS TO THE EDITOR.

CALCULATION OF TERMINAL VELOCITIES.

To the Editor of Engineering.

Sir,—The elegant mathematical artifice described by Mr. Dennison, on page 294 of your issue of April 11, deserves the close attention of engineers, since it provides, as Mr. Dennison claims, a simple and direct solution for a class of problem that is likely to be encountered more and more frequently as dimensional methods of analysis come into general use. So much evidence has been forthcoming, of late, in favour of these methods as to put their value beyond dispute for the presentation of experimental results and performance characteristics relating to hydraulic apparatus and other specific problems entailing fluid motion. In many cases, however, it is a serious obstacle to the use of recent research in these subjects for the solution of practical engineering problems that scale effects are by no means negligible and cannot be generally formulated. Thus the important relation between one non-dimensional characteristic group of physical quantities, in which the engineer is mainly interested, and another basic group, such as the Reynolds number, commonly takes an irregular form of which the graph accompanying Mr. Dennison's letter is a typical example.

The hitherto usual way of using such a graph—an initial guess at the Reynolds number followed by a succession of approximations—is cumbersome and must have retarded the practical application of new information, since the analytical study of the data and the preparation of graphs or tables for routine use are a considerable undertaking, as is apparent from the original paper on the "Calculation of Terminal Speeds," to which Mr. Dennison's letter refers. Preparation of this sort has probably been made only for one or two special problems, and while it has certain advantages for work requiring closely similar problems to be solved so frequently that the computations can well become mechanical, it has, for occasional use, the detriments of making the method of solution appear somewhat artificial and of distracting attention from the fundamental, experimental basis of the operation. Not the least merit of the method proposed by Mr. Dennison is that the basic graph, with its important implications, is all the time under the eye of the user.

Undoubtedly its greatest advantage, however, is that, by permitting an otherwise difficult class of problem to be solved graphically from data which can themselves only readily be presented graphically, it offers an incentive to the more widespread adoption of dimensionless formulation and the use of new knowledge from aeronautical and hydraulic laboratories. Already engineering developments dependent on this knowledge are of recognised importance in such directions as filtration, dust extraction, pneumatic conveyance of powders, wind loading of wires and structures, flow of oils and gases, and many forms of hydraulic and ventilating machinery. The list is significant of the potential value of Mr. Dennison's contribution to engineering science.

Yours faithfully,
F. C. Johansen.

Research Laboratories,
L.M.S. Railway,
Derby.
April 21, 1941.

TOOL DYNAMOMETER FOR MEASURING RAPID FORCE FLUCTUATIONS.

To the Editor of Engineering.

Sir,—An interesting question regarding calibration of the De Forest scratch extensometer has been raised by Messrs. J. C. Roach and J. O. Cowburn, in a letter appearing in your issue of April 18, page 315. Results of carefully conducted calibration tests are described, and it is claimed that these reveal an inherent error in the instrument of the order of 13×10^{-4} in. on a 2-in. gauge length. The suggestion is then made that the results quoted in my article "Tool Dynamometer for Measuring Rapid Force Fluctuations" must be in error, if no correction has been made for such inaccuracies. That the results of their calibration tests are accurate I have not the slightest doubt, but the conclusions which they deduce are quite untenable. I base this statement not only on theoretical grounds, but on the indisputable evidence of the extensometer itself. It may be of interest to know that I have recorded complete records with the scratch extensometer in which the maximum amplitude is less than 13×10^{-4} in., *i.e.*, less than what is suggested to be the inherent strain error of the instrument. A photograph of one of these scratch records may be seen in a past publication (page 233), "Impact Stresses in a Freely-Supported Beam" (*Proc.I.Mech.E.*, vol. 137, page 217 (1937)), where a complete impact, comprising four sub-impacts, is recorded for a weight striking a beam with a velocity of 1·64 ft. per second. The amplitude of the first sub-impact in this case is almost exactly 13×10^{-4} in., the later ones being even smaller.

The theoretical reason for this seeming contradiction is not difficult. The calibration tests carried out by Messrs. Roach and Cowburn were obviously conducted statically, the friction between the target and abrasive being much greater than under dynamic conditions. The De Forest extensometer, however, was never designed to record static strains; it is inherently an extensometer for recording high-frequency phenomena and cannot be calibrated by static means. Any discrepancy in recording is due to shearing of the abrasive pad due to the frictional load required to produce the scratch. Suppose, for instance, that the pad were to shear an amount δx before slipping commenced. The maximum strain recorded would, therefore, be in error by δx and on return to zero strain, the scratch would stop at the new zero position $+\delta x$. Careful tests conducted under *dynamic* conditions have shown that this zero shift is extremely minute, and in most cases non-existent. In my researches with these instruments I have always made use of fine rouge paper as the abrasive, a small piece being cemented to the extensometer arm. Being only 0·005 in. thick, the rouge paper minimises any errors which might occur due to the shearing action.

Yours faithfully,
Ronald N. Arnold.

Research Laboratory,
Metropolitan-Vickers Electrical Company, Limited,
Trafford Park, Manchester, 17.
April 22, 1941.

THE VACUSTAT.

To the Editor of Engineering.

Sir,—Your description of the Vacustat in Engineering of April 18, page 306, is interesting to me, because you describe it as "A modification of the gauge invented by Professor McLeod, of Coopers Hill College, as far back as 1874." The inventor of the gauge was my father, and I have in my possession the capillary tubes used in some of the early experiments. All these are dated 1870, and it is probable that the gauge was first made soon after this date. The tubes are mounted on microscope slides under glass cover plates, surrounded by Canada balsam. By this means the magnifying effect of the glass tube was eliminated, making it possible to measure the diameter of the bore under a microscope using a micrometer eyepiece.

The tubes had been connected to globes of known volume and unknown vacua; the globe had then been allowed to fill with mercury at atmospheric pressure, which filled it and ran up the capillary tube as far as the remaining air would allow. The capillary tubes were then broken off with the mercury in them and mounted on slides for measurement. One slide is dated January 14, 1870, and bears this inscription:—"Air left on exhausting by a Sprengel, a globe 171·45 cc. capacity, 0·53 mm. long, 0·03 mm. dia., vol. = 0·000037463 cc., $\frac{1}{4,576,453}$ of original air."

The gauge was described at a meeting of the Physical Society by its inventor merely as a means of measuring low gas pressures. The name McLeod gauge was given to it by one of the physicists of the time, who, I believe, later became Sir William Crookes.

Yours faithfully,
R. C. McLeod.

Bedford.
April 22, 1941.

THE EFFICIENCIES OF THE CENTRIFUGAL PUMP.

To the Editor of Engineering.

Sir,—Mr. Maude, in his letter published on page 195 of your issue of March 7, gives an example to show the application of the velocity head correction. The suggestion which he questioned dealt with the conditions on the delivery side of the pump, where (to take the case of his first pump, having 12 in. suction and 10 in. delivery branches), if site conditions called for a 10-in. to 12-in. taper piece to suit a 12-in. delivery main, the 1·2 ft. head with which the pump had been credited on the test bed

would not be recovered, due to the disturbed nature of the stream and the relatively poor efficiency when converting from velocity to pressure.

Mr. Jennings, in his letter in ENGINEERING of April 4, page 276, does not comment on the suggested classification of impeller friction loss; perhaps because he finds it difficult to understand the statement that the vanes are being driven through the absolute streams. It is equally difficult to think of a better illustration of the fact than is given by Fig. 2, in my letter on page 215, *ante*, except that an arrow should have been shown to indicate that the vanes were moving through the streams in an anti-clockwise direction.

The failure to realise that the "flow" in the channels is relative is best illustrated by a consideration of the treatment accorded to the design of extraction-pump impellers, where a generally accepted rule is that the relative velocity must not exceed 12 ft. per second. The authority who adopted this number could not have been more unfortunate if he had fixed on 13 as the limiting value, as more than one manufacturer has been forced to two-stage, and in some cases to three-stage pumps, to perform duties that have been obtained quite easily, more efficiently and at much less cost, by single-stage pumps fitted with impellers of a rational design. Applying this rule to a tip speed of, say, 50 ft. per second calls for an absolute velocity of nearly 40 ft. per second to fulfil the diagram. Comparing this absolute velocity with an absolute velocity of 5 ft. per second in the eye shows how absurd the rule is. Applying the formula for x, on page 215, will give much food for reflection.

Doubtless the same difficulty explains Mr. Jennings' statement that a frictional loss cannot increase the head; if he were to sketch an exit diagram and substitute in the fundamental equation $H = \frac{u_2 v_{w_2}}{g}$ for a frictionless fluid and then make a suitable allowance for the effect of channel friction on the relative velocity, he would find that the claim, that an increase of head is indicated, is not manifestly impossible.

No direct answer is given to the question whether the relative velocity can be varied at will. Although the point is stated to be only of technical importance, a simple arithmetical calculation is dismissed on the score of expediency; necessitated, unfortunately, by the fact that few impellers have vane angles and areas at inlet that conform to any known diagram. The trailing surface of the vane should be an involute curve giving the correct angle at the tip, and the leading surface should be formed so that the absolute streams beyond d_1 are always in the direction of rotation. How many impellers fulfil these conditions?

The interesting and valuable work carried out by Fischer and Thoma, to which reference is made, substantiates the statement that modern authors are wrong in making an allowance for pre-rotation, as the photographs show that over a range of output the entry is radial; they confirm, also, that the full-line diagrams shown in Fig. 1, on page 215, *ante*, are correct, as the absolute streams are more or less radial before and after entry, thus conforming to natural streamline flow.

Yours faithfully,
G. URE REID.

Inzevar,
Dollar, Clackmannanshire.
April 25, 1941.

SOUTH AFRICAN COMMERCE.—The value of the total imports through all the ports of the Union of South Africa, in March, amounted to 9,160,000*l.*, compared with 8,339,000*l.* in the corresponding month of 1940. The total exports in the same month, excluding gold and wool, were valued at 2,695,000*l.*, against 2,535,000*l.* in March, 1940.

THE CONTROL OF PAPER.—The Ministry of Supply has issued the Control of Paper (No. 32) Order (S.R. & O. 1941, No. 528, price 2*d.*), which came into operation on April 21. It imposes further restrictions on the use of paper for posters, circulars, loose inserts in publications, labels, greeting cards and programmes. The new restrictions are additional to those previously in existence.

THE BRUSH SURFACE ANALYSER.

IN our issue of March 29, 1940, page 343, we gave a summary of a report on a research on surface finish by Dr. G. Schlesinger. In this report a number of methods of measuring surface finish and of instruments for making such measurements were described, and it may be of interest to add to this an account of a recent instrument, known as the Brush Surface Analyser S.A.1, now being distributed in this country by Messrs. A. C. Wickman, Limited, Coventry. The instrument records the irregularities of the surface under examination on a moving paper chart, and the degree of magnification available enables satisfactory records to be made of surface irregularities smaller than one-millionth of an inch, the form as well as the amplitude of these irregularities being indicated. The measurements are recorded directly, no conversion formula being needed, and values in fractions of a micro-inch may readily be determined.

The Brush Surface Analyser consists of three main units, viz., the analysing head, the calibrating amplifier and an oscillograph furnished with a direct inking pen. The analysing head, which is fully enclosed, is mounted on a circular column with a three-footed base, and may be moved up and down the column or radially through a full circle. A lever-mounted arm projects horizontally from a point underneath the head and carries at its free end an exploring stylus of sapphire with a point having a radius of 0·0005 in. The motion of this stylus over the surface irregularities of the material under test is transmitted by means of a mechanical linkage to a piezo-electric crystal. The pressure on the crystal due to the movements of the stylus gives rise to minute electrical currents of the order of 0·0015 volt per micro-inch of deflection of the stylus, the current being transmitted through the electrodes in which the crystal is mounted to the amplifier and thence to the oscillograph. The motion of the stylus may be varied at will to either a straight line reciprocating movement of 0·05 in., or a circular one 0·05 in. in diameter. The time cycle for each motion is 15 seconds. The analysis head stands upon a cast-iron surface plate with an area of 14 in. by 10 in. The plate is supported on four rubber cushions to damp out vibration, and, of course, carries the material under test, which may be metals, glass, paper, painted or plated surfaces, etc. Two Vee-blocks provided enable cylindrical work to be examined.

The construction of the crystal element, its mounting and electrical connections are designed so that the sensitivity of the analysing head is virtually independent of such temperature variations as may normally occur. The stylus is mounted in a protective tubing provided with a hardened steel shoe which locates the stylus in a vertical plane and rides over a relatively wide area of the surface under examination in order to provide a reference level. The arm is pivoted at the end remote from the stylus with a spring-loaded conical bearing attached to the driving mechanism. This mechanism comprises gearing and cams for imparting the linear and circular movements above referred to and is actuated by a flexible shaft from the small motor operating the oscillograph chart. The motions are selected by a knob on the top of the gear case. The amplifier is of the two-stage type and has been specially designed for the instrument. It is supplied with equipment enabling it to be operated from a 110/120 volt, 60-cycle supply. A step-down transformer suitable for 220/250 volt supplies can be provided if desired. A step-type attenuator for reducing the amplitude of the current oscillations provides a means varying the amount of magnification of the oscillograph pen movement. A calibrating circuit is included to provide a "test" voltage for adjusting the gain of the amplifier in order to obtain any desired deflection on the oscillograph chart accurately correlated to the sensitivity of the pick-up arm. With the most sensitive setting of the amplifier the deflection on the chart may be as high as 3 mm. (0·118 in.) per millionth of an inch stylus deflection.

The oscillograph traces on a moving chart the irregularities of the surface under test as picked up by the stylus and magnified by the calibrating amplifier. The direct inking pen is actuated by a crystal element, the electromotive force derived from the amplifier inducing a strain in the crystal which is translated into movement of the pen. The mass and stiffness of the pen are such that it can respond to rapid fluctuations, up to 60 or more vibrations per second, sufficient power being delivered to overcome friction. The curves drawn by the pen are correct representations of the irregularities of the surface profile and not the mean departure from a theoretically flat surface. A maximum deflection of approximately $\frac{1}{2}$ in. on each side of the zero line is obtainable, which gives an open and easily-read chart. The chart motor is of the synchronous type and provides a constant chart rate, through a three-speed gearbox, of 0·2 in., 1 in. or 5 in. per second, the first speed being equivalent to approximately 20 times linear magnification, the second to 100 times, and the third to 500 times. For most surface examinations it would appear that a feed of 1 in. per second provides the most easily interpreted chart.

Both the amplifier and the oscillograph are self-contained in metal cases and can be disposed as convenient to the analysing head. The head is connected to the oscillograph by the flexible shaft 2 ft. long, providing the stylus drive and by a two-conductor shielded cable 5 ft. long, the head and the amplifier being coupled by single-conductor shielded cable, also 5 ft. long. The whole apparatus is contained in two carrying cases, one measuring 19 in. by 19 in. by 11 in. deep for the three instruments, and in loaded condition weighing 57 lb., and the other measuring, 15½ in. by 11½ in. deep and only a few inches wide, holding the surface table, and in loaded condition weighing 55 lb.

THE UNIVERSITY AND INDUSTRY.*

By RALPH E. FLANDERS.

IT was a happy thought which led those in charge of this event to call for a re-examination of the part which the university plays, or should play, in the common welfare. The problem of ministering to the needs of this generation and the generation to come is the first responsibility of those who guide the destinies of the university. Among the varied relationships to be examined and discussed to-day are those of the university with agriculture, the professions, the social services, and humane living. The subject assigned for this meeting is "The University and Industry." Seen in all its relations, this topic takes rank with any and all of the others proposed. The kind of life we are living, the kind of world we live in, the problems which dominate our existence, and which must be solved lest we perish, have their roots in industry. The responsibilities of the university to the industrial life of the nation touch the very centre of its existence.

Let us first give some thought to the practical details of the organisation of one of the major branches of the university—the school of engineering. A considerable variety of types exists among practising engineers. I believe, in fact, that at least three types of engineering education are necessary to meet the variation in training needed for different existing conditions. We may divide the functions of engineers into seven different classes. Some engineers may confine themselves quite narrowly to one function; other individuals will find their daily work including two or three, or even more, functions, or even, perhaps, in extreme cases, all of them. A suggested tabulation of functions would be:—Maintenance; operating and processing; production methods; executive functions; designing; consulting; and research. It will be noted that these functions are not given in the order of the monetary rewards involved. The order roughly gives in ascending degree the rigour of engineering training required.

The first three functions may be said to constitute the group of technicians, in which perhaps a less rigorous preparation is permissible and a broader study of details is more desirable than in the case of the other types of functions. In this group it is essential that the student shall have a thorough knowledge of the mechanisms and processes in the broad field of mechanical engineering, that he shall have a fair grounding in fundamentals, and that he shall know where to go for information on subjects with which he is concerned.

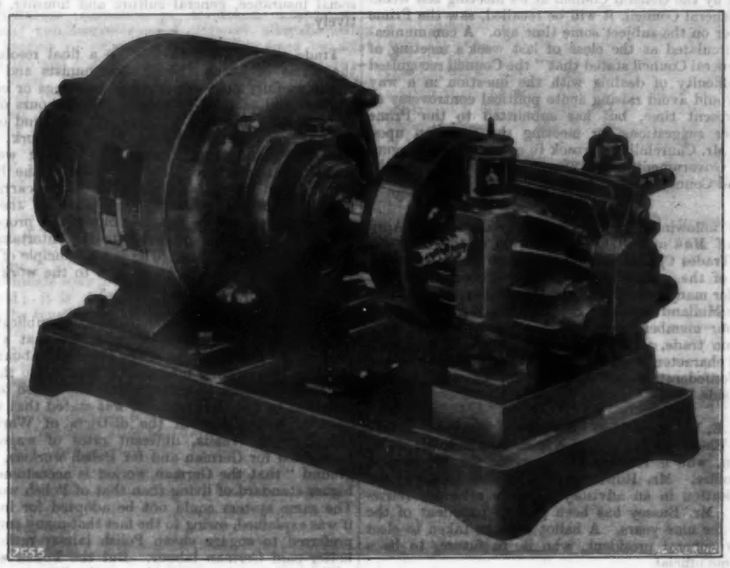
The fourth group, that of executive, is in a class by itself. Many engineering schools recognise this by setting up industrial engineering courses aimed especially at the training of the manager. It would be interesting to know how many of the executives who have come to the top through the engineering route had specialised training in management in their student courses—and how many of them took a purely engineering training. There is no question as to the large percentage of successful executives who have had engineering training. If it were possible to discover in advance which students in an engineering course were to become executives, it would be desirable to give those students a somewhat broader training, particularly in economics and English.

The third group (the designers, the consulting engineers, and the research men) all require the most rigorous training in fundamentals, and it is highly doubtful whether elaborate courses on the details of present practice are anywhere near as valuable as this thorough grounding. The "present practice" of the schools is almost invariably behind the developing present practice in the field, and the area that would have to be covered in a study of present practice would be so great, not knowing the field into which the graduate was going, that it would be impossible

* Address delivered on the installation of Dr. Howard L. Bevis as President of Ohio State University. Abridged.

3-CUB. FT. AIR COMPRESSOR AND VACUUM PUMP.

MESSRS. W. EDWARDS AND COMPANY, (LONDON), LIMITED, LONDON.



to save time for the fundamentals. The fundamentals are the essential. But here, as well as in the training of the candidate for an executive position, a broadened training in such things as economics and English should be added to the deep and thorough training in fundamentals.

The question of English seems to me to be particularly important. The number of engineering graduates, or, indeed, the number of college graduates in general, who do not spell correctly, or do not write with proper grammatical construction, is astonishingly large. These men are handicapped from the start when they get out in life. One suggestion I might make is that engineering written work be graded separately for technical content and for English; and that the grading for English be done by English teachers, rather than by the technical teachers.

The above discussion leads to the suggestion of three types of curricula, all three of which it might not be feasible to carry on in the same school. This in turn leads to the notion of schools for technicians, schools for industrial executives, and schools for engineers in the strictest sense. One or two points may be worth bringing up. The first has already been touched on in connection with the question of trying to follow up "present practice" in schools. A most important element in education is summer vacation work in some engineering line allied to the course the student is taking and to the particular interests in engineering which he is following. Unfortunately there are many years in the course of a business cycle in which it is very difficult to get employment of this sort. Every effort should be made by the student to obtain it.

But there is another reason for emphasising summer work or a year of work between high school and college. Without such work, the student comes into industry completely unadjusted to industrial life. He does not know what it means to work for a living. The jobs he may be given as a part of his post-graduate industrial training are too often approached as though they constituted a laboratory exercise instead of being a part of a day's work of the world. Furthermore, the student's relations with his fellow-workmen and with his superiors are almost certain to be such as will handicap him until he makes new and more realistic adjustments. All these difficulties will be minimised if the boy can get a real job as early in life as possible. He should endeavour to get as well adjusted to work as the boy who has had to work for a living since he arrived at the legal age for leaving school.

Engineering is so nearly the foundation of modern industry, and industry is so nearly the foundation of modern life, that it is hopeless to make a sharp division between my first topic, which relates to engineering, and my second, which relates to industry in general. It is just as impossible to make a sharp division between the responsibilities of this university to industry and its other responsibilities. Nevertheless, it will be worth while to look at the educational problem from the standpoint of business as a whole.

The process of education should help, rather than hinder, the adjustment of the student to industrial life. The student should learn to work with people. He should understand that, while successful co-operative effort may and should result in advantage to the individual, that advantage will not ordinarily accrue to him who fixes his eye too intently on the personal advantage rather than on the co-operative achievement. The university will need to learn, particularly in its sociological divisions, that men are not alike, that they do not have the same emotions, the same driving forces, the same problems. Perhaps there is nothing more astonishing to the college graduate who goes out into industry than the discovery that by far the greater percentage of mankind is happiest in a routine job. Those who analyse and systematise human activity into text-book form would not be happy under routine conditions, and, therefore, find difficulty in adjusting their minds to the concept that others may differ so greatly from themselves.

A complementary concept must be established in the mind of the young man of ability and training who goes out into industry. That concept is that, with the group which seeks responsibility rather than routine, that responsibility is very deep and widespread. That responsibility is for the well-being and security of that major part of humanity which is unwilling or unable to take responsibility. If the advantages of security and well-being are to be available to the mass of mankind, the exceptional man must be educated to the idea of venture, risk, and responsibility. It is not the least serious of the new tendencies of our time that the idea of security, as against enterprise, has been injected into the bloodstream of industrial management and industrial financing. Unless this poison can be eliminated, there will be no well-being and no security for the mass of the workers—no solvency nor permanent beneficence in the government which is sustained by their votes. If we are to be safe, the next generation of the leaders of society now being trained within these walls must be familiarised with business enterprise, business risk, even while discharging their responsibilities of conserving the well-being of the larger proportion of routine workers dependent upon them.

The sum total of the problems and opportunities found in the general subject of the university and industry forms a composite problem of very great dimensions. Yet the problem itself is something much greater than the sum of the parts we are discussing here to-day. Over and above the parts exists the general problem of discovering how the truly educated man can be effective in guiding the destinies of a democracy. We can plainly see how this university can improve agriculture, how it can train men for the professions, how it can serve industry, how it can develop the social sciences, and how it can prepare its graduates for humane living. What it is not so easy to see is how these separate but interrelated activities can be focused on the over-all control of our national destiny for the benefit of our fellow-citizens and ourselves.

The rôle of the scholar with a liberal or technical education, or a combination of the two, is quite clear in the new types of government arising elsewhere in the world. He no longer exists as a free agent. His attainments are directed in detail to serve the inferior purposes of a society organised on superior force. The rôle of the educated man in a modern democracy is by no means so clear. The chasm between knowledge and goodwill, on the one hand, and political accomplishment, on the other, is deep and wide. Meanwhile, our destinies are guided more and more directly, over a larger and larger area, by forces acting in the political field. This is the great undertaking—an effective relation between the university and the sum total of the secular activities of our nation. This is the problem which must be solved, and the manner of whose solution is as yet by no means clear. We do not believe that it cannot be solved. We do know that its solution will require the full devotion of every one of us.

3-CUB. FT. VACUUM PUMP AND AIR COMPRESSOR.

THE small-capacity air compressor and vacuum pump has been found, particularly under present-day conditions, to prove of great value, not only in laboratories and works which require pressure or vacuum at infrequent intervals only, but in those where the demand is not large enough to make it worth while to install permanent plant of greater power. In this latter instance, a small plant of sufficient portability to be handy is of considerable service in situations not furnished with pressure or vacuum pipe lines. Messrs. W. Edwards and Company, (London), Limited, Southwell-road, Loughboro' Junction, London, S.E.5, have recently introduced an improved design of their small-capacity motor-driven vacuum pump and air compressor, which is known as the "Type IV Unit" and is shown in the accompanying illustration.

As generally supplied, the unit is complete, with a directly-coupled motor on the same base as the pump, and no auxiliary fittings are required. The displacement is 3 cub. ft. per minute, and, when used as an exhauster, a vacuum of 24 in. of mercury can be obtained, and when used as a compressor, a pressure of 10 lb. per square inch above atmosphere is reached. These figures are with a motor of ¼ h.p., running at 1,425 r.p.m. With a ⅓-h.p. motor the pressure can be increased to 15 lb. per square inch, the vacuum obtainable remaining the same. Since the complete unit occupies a space of only 16¼ in. by 8½ in. by 8½ in., and weighs no more than 56 lb., it is both readily portable and easily accommodated. The normal current supplies for which the motors are provided are single-phase, 50 cycles, 100/250 volts, three-phase, 50 cycles, 100/550 volts, or direct current 100/250 volts. The single-phase motors only are provided with a control switch. Switchgear for three-phase motors and for direct-current motors is only provided to order. All motors are of the enclosed drip-proof type with wool-yarn packed sleeve bearings primed with sufficient oil to last the lifetime of the motor if on intermittent service. On continuous service, a small quantity of oil should be added every 12 months.

It will be clear that the pump is of the vaned rotor type and particular care has been taken to ensure efficient air-cooling, to avoid the difficulties of installation and maintenance attendant on water cooling. The rotor casing is provided with deep fins over which the air is circulated by a multi-bladed fan on the rotor shaft. The motor spindle and rotor shafts are connected by a coupling having a resilient washer. The surface of the coupling is kept free from projections to ensure safety in working, the key seen lying on the bedplate being for manipulating the grub screws employed. The shaft runs in long bronze bearings. The lubricating system includes an arrangement whereby oil is collected continuously from a large chamber and is pumped to the rotor and blades. The constant oil bath thus provided for all the working parts should have the effect of reducing wear to the minimum. It is stated that pumps working continuously for 24 hours daily suffer no loss in efficiency.

The nozzle seen to the right is that for the vacuum connection and the chamber carries a removable cap and filter. The nozzle on the left is for the pressure connection. Its chamber is surmounted by an automatic relief valve. Before issuing from the outlet, the delivered gases are filtered and any oil collected is returned to the sumps. Fittings for special uses of the machine include an adjustable leak valve when it is desired to maintain the vacuum at any specified value; a cyclone attachment for the suction side for use when aspirating flue gases or wet or dusty gases; an additional oil feed for rinsing the pump when acid vapours are present; and an air filter on the suction side when the machine is used as a compressor.

DRAFT SPECIFICATION FOR EXTERNAL MEASURING COMPARATORS.

A DRAFT specification for engineers' comparators for external measurements has now been issued by the British Standards Institution and is being circulated for technical comment. Those interested are invited to apply for a copy of the draft under the reference number CF (ME) 7708, and to submit their comments, to arrive not later than June 2, 1941, to the Director, British Standards Institution, 28, Victoria-street, London, S.W.1. The comparator is defined as a measuring tool, consisting, in essentials, of a measuring head on a rigid stand over a work table, the head being provided with a measuring contact the movements of which, after being amplified by some form of mechanism, are indicated on a scale. The distance between the measuring head and the table is adjustable to suit work of different sizes. The specification does not apply to comparators with measuring heads giving a magnification of less than 250, nor to those with dial indicators the pointer of which turns through several complete revolutions. Owing to the diversity of design of comparators, the amplifying mechanism of which may be mechanical, electrical, optical, fluid or pneumatic, the specification is concerned mainly with the desirable accuracy of performance. The table is to be of steel hardened to a diamond pyramid hardness of not less than 850. The working surface is to be finished by lapping and the maximum error from the mean true plane is not to exceed $\pm 0{\cdot}00005$ in. over a central area up to 3 in. in diameter. Any departure from flatness is to be a convexity, not a concavity. The surface may be grooved for dirt clearance and may be chromium plated. The head is to have coarse and fine adjustments with efficient clamping devices. The fine adjustment must enable the instrument to be set to zero without difficulty to within 0·1 of one scale division. The measuring contact is to be of hardened steel of not less than 850 V.P.N. or other material of even greater hardness and durability. The point of the contact is to be normally rounded, but may be flat by mutual agreement of purchaser and manufacturer. The operating pressure to obtain zero reading is recommended to be about 8 oz. The pressure should not vary substantially throughout the measuring range. Stops are to be provided to the mechanism. In dial-reading instruments the pointer is to be attached to its spindle so that in no circumstances shall there be relative movement.

The scale is to be either of black graduations on a white ground, or of definitely contrasting colours, and should be easy to read under ordinary good workshop lighting conditions. The graduations are to be equal in thickness, sharp in outline and uniform throughout their length. The thickness suggested is one-twentieth of the distance separating two main divisions. The tip of the pointer should be approximately of the same width as the graduations and there should be no appreciable parallax between the pointer and scale. The equivalent value of one main division of the scale is to be clearly marked and the graduations numbered at least at every tenth main division.

When the instrument has been set to read on an object, the reading should not change by more than one-tenth of one scale division on tapping. When a cylinder is rolled under the contact in different directions, the reading is not to change by more than one-tenth of one scale division. If the measuring head be provided with means for raising and releasing the contact, repeated applications of the contact on the surface of the work table shall give no variation in reading exceeding one-tenth of one scale division. The accuracy of the scale divisions is to be tested by taking readings on a suitable series of slip gauges, first over the positive half of the scale and then over the negative half, the tolerance on each reading being equal to plus or minus 1 per cent. of the reading, or the appropriate amount given in a table of the specification. Representative figures from this table show that, for a magnification factor of from 600 to 1,000, the minimum tolerance on reading is $\pm 0{\cdot}00003$ in., or $\pm 0{\cdot}0008$ mm. With a magnification factor of from 250 to 299, the minimum tolerance is $\pm 0{\cdot}00008$ in., or $\pm 0{\cdot}002$ mm. The magnification factor is obtained by dividing the distance between the divisions on the scale by the equivalent displacement of the measuring contact; thus, if the distance between the divisions measures 0·09 in. and one division represents 0·0001 in., the magnification factor would be 900. The tolerances in the table may be compared with the plus or minus 1 per cent. referred to above, as follows:—With a comparator having a magnification factor of 900, the tolerance on all readings up to 0·003 in. would be $\pm 0{\cdot}00003$ in., and on larger readings plus or minus 1 per cent. of the readings. With comparators having electrical or optical amplifications, care is to be taken that the settings are not disturbed by heating effects or voltage fluctuations.

LABOUR NOTES.

THE efforts which the Trades Union Congress are making to induce the Government to revise, to some extent, the provisions of the Trade Union and Trade Disputes Act, 1927, were amongst other matters discussed by the General Council at its meeting last week. The General Council, it will be recalled, saw the Prime Minister on the subject some time ago. A communication circulated at the close of last week's meeting of the General Council stated that "the Council recognised the difficulty of dealing with the question in a way that would avoid raising acute political controversy at the present time, but has submitted to the Prime Minister suggestions for meeting the situation upon which Mr. Churchill undertook to consult his colleagues in the Government and to communicate again with the General Council as soon as possible."

The following editorial note appears in the April issue of *Man and Metal*, the journal of the Iron and Steel Trades Confederation:—"As we go to press, we learn of the sudden death of Mr. Richard Lowndes, who, for many years, has been the employers' secretary to the Midland Iron and Steel Wages Board. We are sure our members, particularly those connected with the iron trade, will regret his passing. He was of a genial character, candid but fair in his statements, and the Confederation loses one of its friends 'on the other side.'"

Mr. E. W. Bussey has been elected general secretary of the Electrical Trades Union in succession to Mr. J. W. Rowan, who is retiring after serving for 34 years in that office. Mr. Rowan is to continue to serve the organisation in an advisory capacity after his retirement. Mr. Bussey has been general president of the union for nine years. A ballot is to be taken to elect a new general president, who is, in future, to be a full-time official.

Under an award of the Australian Commonwealth Court of Arbitration, women workers may be employed in the textiles industry between the hours of 7 a.m. and 10 p.m., because such employment is "urgently needed to carry out defence contracts for the Commonwealth Government." A previous award prohibited the employment of women workers after 9 p.m. In making the award, Mr. Justice O'Mara said:—"I am of the opinion that there should be as little factory working by females as possible and it should finish at the earliest hour; but, once night work is permitted, I think it should be regulated in a reasonable and flexible manner without regarding the hour of 9 p.m. as sacrosanct, particularly when this can be done to the improvement of the monetary position of, and without injury to, employees earning low incomes."

After discussion, a plenary meeting of the Central Council of Trade Unions of the U.S.S.R. arrived at the conclusion that a reform of trade union activity was necessary to the extent of organising and educating the masses in the spirit of communism, promoting a socialist attitude towards labour, developing socialist emulation and the Stakhanovist movement, organising the masses to fight for increased output, improving the quality of production, strengthening of labour discipline, improving labour protection and safety technique and meeting more adequately the cultural and material needs of trade unions. These objects, it was declared, could be achieved only by the widespread and effective participation of active members in the work of the trade unions.

The meeting adopted a number of resolutions embodying these conclusions. One called for a reduction in the number of paid trade union officials to one-half or one-third, and insisted that such officials should no longer be paid out of the funds of the undertaking or establishment. The number of officials on works' committees was fixed at a figure ranging from two (undertakings and establishments with 500 to 2,000 employees) to ten (undertakings and establishments with over 35,000 employees). Workshops with over 1,500 employees might engage a paid official. The greater part of the money drawn from contributions was to be used for the cultural betterment and the assistance and improvement of the technical skill of trade unionists.

Trade unions, another resolution declared, must re-organise their work in such a way as to give their members a greater share in all trade union activity (wage committees, labour protection committees, social insurance boards, etc.). The basic units of the trade union movement, known as "trade union groups," must reduce their membership to not more than 20 persons. Trade union meetings must be held more often than has hitherto been the case. The presiding boards (presidiums) of the trade union committees for the different regions, territories, towns and districts are abolished, together with the services attached to them. In order that a large number of workers may serve in the management of the trade unions, special committees must be attached to the trade union committees for organisation, labour protection, wages, social insurance, general culture and housing, respectively.

Trade unions are forbidden, in a final resolution—the terms of which British Communists and others might usefully note—to organise meetings or convene workers and salaried employees during hours of work or to require members to carry out any kind of work for the organisation during hours of work. Shop stewards would have a lean time if that were the trade union rule here. The activities of the Russian cultural institutions and clubs are to be carried out largely with the voluntary assistance of the trade unions. They will be financed out of the proceeds of the fees charged for admission to the entertainments, concerts, etc., organised. The same principle of voluntary collaboration is to be applied to the work of the sports' societies.

The *International Labour Review*, a publication of the International Labour Office, states that a recent issue of the official organ of the German Labour Front contained interesting information relating to the wage policy of the German authorities in the Polish territory occupied by the Germans. It was stated that in agriculture, particularly in the districts of Warta and Danzig-West Prussia, different rates of wages have been fixed for German and for Polish workers, on the ground "that the German worker is accustomed to a higher standard of living than that of Polish workers." The same system could not be adopted for industry, it was explained, owing to the fact that many employers preferred to engage cheap Polish labour rather than better-paid German labour. But the Polish workers, while receiving the same wages as the German workers, were required under various Orders issued by the German Governor to pay from 15 per cent. to 20 per cent. of their wages to the German Government.

The United States Supreme Court has refused to review a decision of a lower court and, thereby, upholds the right of the Wage and Hour Division to make routine inspections of the pay-roll records of employers subject to the Fair Labour Standards Act. The Federal District Court in Chicago and the Circuit Court of Appeals had ruled that the Division may require an employer to produce wage and hour records in order to determine whether the Act had been, or had not been, violated. The decision of the district court also upheld the constitutionality of the Act, but that question was not made an issue on appeal. Briefly, the Wage and Hour Division had conducted an investigation into the acts and practices of the Kansas City branch of Messrs. Montgomery Ward and Company relating to hours of labour, wages, classification of employees and alleged discriminatory acts. In the course of the investigation, the administration had ordered the production of wage and hour records, and, upon the refusal of the company to comply, brought an action to compel the production of the company's records.

The company objected on the ground that the order required the production of records of all employees, whether or not covered by the Act. It was also contended by the company that the Division should show reasonable cause to believe that the employer was violating the Act. The Circuit Court held that the Wage and Hour Division was empowered to inspect wage and hour records of an employer without even showing reasonable grounds to believe that the employer had violated the Act. The Court declared that inspection of an employer's records under such circumstances was not an unreasonable search and seizure in violation of the fourth amendment to the Constitution, and further, that it would be inconsistent with the scope and purpose of the Act to limit the inspection of books and records only to cases in which the Administration had reasonable cause to believe that an employer had violated the Act. The authority of the Administrator was held also to be unimpaired by the fact that the records of the employees not covered by the Act would be disclosed and that producing them would be an onerous burden upon the company.

An employment and social insurance law passed in Canada in 1935—which provided for compulsory unemployment insurance—was later declared unconstitutional, but an amendment to the British North America Act passed on July 10, 1940, removed the constitutional barriers to the establishment of such a system. As a result, an Unemployment Insurance Bill was introduced in the Canadian Parliament and is now in operation.

EFFECT OF PROLONGED HEATING AT 80 DEG. C. ON COPPER WIRE.*

By E. VOCE, Ph.D., M.Sc.

IN the course of a paper upon the "Effect of Temperature Attained in Overhead Transmission Cables," von Zeerleder and Bourgeois†, after discussing the heating of overhead transmission lines by solar radiation and the passage of electric current, wrote:—"In order . . . to get reliable figures, hard-drawn wires of copper, pure aluminium and Aldrey‡ were exposed to relatively low temperatures for periods ranging over several months up to one year. It was found that copper and pure aluminium, if kept at 80 deg. C. for 41 days (1,000 hours), were completely annealed, whereas Aldrey was not in the last affected by temperatures up to 100 deg. C., even if applied for one year (8,760 hours). A marked diminution of tensile strength could be observed only at temperatures of 120 deg. C. and over." No details of the analysis of the copper or pure aluminium used in these experiments were given, nor were any actual test results quoted; it is clear from the last sentence, however, that the tensile test was employed to assess the degree of softening or annealing.

Howell and Paul§ have referred to the work of von Zeerleder and Bourgeois in connection with aluminium and have published figures which show that hard-drawn commercial aluminium of 99·21 per cent. purity suffered a diminution in tensile strength of only 5 per cent. after 652 days at 100 deg. C. Even after 139 days at 150 deg. C. this material, which

TABLE I.

Duration of Annealing, Days at 96 deg. to 100 deg. C.	Average Tensile Strength. Tons per sq. in.	
	16 S.W.G.	20 S.W.G.
0	30·2	29·0
42	23·2	24·6
100	18·7	22·1

contained silicon 0·13, iron 0·53, copper 0·11, and manganese 0·02 per cent., was not completely annealed. It has been shown, however, that work-hardened aluminium of purity greater than 99·99 per cent. re-crystallises and softens at temperatures below 80 deg. C. A résumé of a number of researches on this point, including those of Calvet; Trillat and Paić; Calvet, Trillat and Paić; and Kratz, has appeared in *Light Metals*.‖ In discussing the paper of von Zeerleder and Bourgeois, Moore described experiments in which high-conductivity copper wires (composition not stated), hard-drawn to No. 16 S.W.G. (0·064 in. diameter) and No. 20 S.W.G. (0·0363 in. diameter) were heated at 96 deg. C. to 100 deg. C. for periods up to 100 days. He gave a series of results from which the figures quoted in Table I have been extracted.

While these figures certainly show that a considerable degree of softening took place at 96 deg. to 100 deg. C., they give no support to the claim that copper is "completely annealed" after 41 days at 80 deg. C., the tensile strength of annealed copper wire being about 15 tons to 16 tons per square inch. As the possibility of softening on heating at relatively low temperatures is important in connection with the use of copper for electrical purposes, an investigation upon well authenticated materials was carried out. A temperature of 80 deg. C. was selected for the tests, with the object of providing a direct check upon the statement of von Zeerleder and Bourgeois already quoted.

TABLE II.—*Electrical Conductivity, per cent. of I.E.C. Standard for Annealed Copper at 20 deg. C.*

Condition.	O.F.H.C.	O.R.C.	C.C.C.
Hard-drawn wires:			
0·160 in. diameter	99·4	100·1	99·7
0·066 in. ,,	98·6	98·9	99·7
Fully annealed wires:			
0·160 in. diameter	101·6	102·0	102·4
0·066 in. ,,	100·2	100·7	100·7

The following well-known commercial varieties of electrolytic copper were obtained for the tests, namely, O.R.C. brand copper, made by the Ontario Refining Company; C.C.C. brand copper, made by the Chile Copper Company; and O.F.H.C. brand copper, made by the United States Metal Refining Company. The first two are oxygen-bearing (tough-pitch) coppers, and O.F.H.C. is an oxygen-free high-conductivity copper. The Ontario Refining Company (now the Copper Refining Division of the International Nickel Company) and the Chile Copper Company each provided a full chemical analysis of a wire-bar cast simultaneously with that supplied for the tests. The United States Metals Refining Company gave an analysis of the cathode from which their wire-bar had been made, stating that O.F.H.C. wire-bar produced at that time contained 0·002 per cent. of iron and less than 0·007 per cent. of oxygen, and that otherwise the composition of the wire-bar could be taken as practically the same as that of the cathode. As a check upon this statement, the silver content of the finished product was determined chemically and exactly confirmed. A determination from the wire-bars. The electrical conductivities of the three materials are given in Table II.

Wires of each material were hard-drawn to 0·160 in. diameter and 0·066 in. diameter by the same manufacturer under carefully controlled conditions designed to impart a tensile strength of as nearly as possible 28·5 tons per square inch to each brand of copper in the thicker wire and 29·5 tons per square inch in the thinner wire. Short lengths, straightened by hand, were heated at 80 deg. ± 1 deg. C. for periods ranging from 1 month to 18 months, after which tensile tests were carried out at room temperature. The specimens were not under stress during the heating. Tests were also made upon the wires in their original hard-drawn conditions, after annealing for 1 hour at 575 deg. C., and after storage for 27 months at ordinary temperature. A gauge-length of 4 in. was used and six specimens of each wire were tested at each stage. Table III records the mean results. In some cases specimens failed to break within the gauge-length and therefore the elongation values do not always represent the average of the full six tests. Individual test results generally did not vary from the mean values by more than about ±0·3 ton per square inch and ±1 per cent. on 4 in. for ultimate strength and elongation, respectively, though when appreciable softening had occurred the variation of elongation was somewhat greater.

TABLE III.—TENSILE TESTS ON HARD-DRAWN COPPER WIRES AFTER PROLONGED HEATING AT 80 DEG. C.

Condition.	O.F.H.C.		O.R.C.		C.C.C.	
	Tensile Strength, Tons per Sq. In.	Elongation, Per Cent. on 4 in.	Tensile Strength, Tons per Sq. In.	Elongation, Per Cent. on 4 in.	Tensile Strength, Tons per Sq. In.	Elongation, Per Cent. on 4 in.
0·160 in. diameter Wire.						
As hard-drawn	28·7	3	28·4	3	28·8	3
After 1 month at 80 deg. C.	28·6	4	27·9	3	27·3	2
,, 3 months at ,,	28·8	4	27·4	4	26·5	4
,, 6 ,, ,,	28·5	4	26·9	4	25·5	6
,, 9 ,, ,,	28·8	4	26·4	4	24·9	9
,, 18 ,, ,,	28·9	4	25·2	7	21·9	14
,, 1 hour at 575 deg. C.	15·4	46	15·4	47	15·4	46
,, 27 months at ordinary indoor temperatures	29·0	4	28·5	3	28·9	4
0·066 in. diameter Wire.						
As hard-drawn	30·2	2	29·3	2	29·7	2
After 1 month at 80 deg. C.	29·5	2	27·0	2	26·4	3
,, 3 months at ,,	29·1	2	25·4	3	23·5	6
,, 6 ,, ,,	29·5	2	24·6	4	21·9	10
,, 9 ,, ,,	29·5	2	23·8	5	20·5	13
,, 18 ,, ,,	29·7	2	22·5	10	18·9	20
,, 1 hour at 575 deg. C.	15·1	40	15·4	43	15·1	43
,, 27 months at ordinary indoor temperatures	30·9	2	30·0	2	29·9	2

TABLE IV.—*Percentage of the Additional Strength Initially Imparted by Drawing Remaining after 18 Months at 80 deg. C.*

Material.	Remaining Work-Hardening. Per cent.	
	0·160-in. Diameter Wire.	0·066-in. Diameter Wire.
O.F.H.C.	98	95
O.R.C.	91	51
C.C.C.	74	26

The results provide conclusive evidence that the softening on prolonged heating at 80 deg. C. of these hard-drawn wires, prepared from electrolytic coppers typical of those in current use, is far less than would be inferred from the statement of von Zeerleder and Bourgeois.

TABLE V.—HARDNESS TESTS AFTER VARIOUS TREATMENTS ON COLD-DRAWN ROD.

Condition.	O.F.H.C.		O.R.C.		C.C.C.	
	Hardness. Vickers Pyramid Nos.	Work Hardness Retained. Per cent.	Hardness. Vickers Pyramid Nos.	Work Hardness Retained. Per cent.	Hardness. Vickers Pyramid Nos.	Work Hardness Retained. Per cent.
As cold-drawn to 50 per cent. reduction	114	100	116	100	115	100
After 1 hour at 200 deg. C.	114	100	114	97	113	97
250 deg. C.	114	100	54	18	48	11
300 deg. C.	108	92	46	8	46	8
350 deg. C.	50	14	44	5	44	5
400 deg. C.	47	9	45	6	45	6
500 deg. C.	45	7	44	5	44	5
(Fully annealed) 600 deg. C.	40	0	40	0	40	0
After 24 hours at 200 deg. C.	112	96	50	21	48	11
250 deg. C.	112	98	45	6	45	6
300 deg. C.	64	32	44	5	44	5
350 deg. C.	44	5	44	5	43	4
400 deg. C.	43	4	43	3	42	3
After holding at 250 deg. C. for—						
10 minutes	116	100	114	97	113	97
1 hour	114	100	54	18	48	11
6 hours	113	99	46	8	46	8
1 day	112	97	45	6	45	6
5 days	105	88	45	6	44	5
1 month	81	55	44	5	44	5

To obtain information upon the behaviour of the coppers when heated in the hard-drawn condition, a rod of each material was drawn to 0·5 in. diameter and then to 0·25 in. diameter, and specimens were heated at 200 deg., 250 deg., 300 deg., 350 deg., 400 deg., 500 deg. and 600 deg. C. for periods of 1 hour and 24 hours. Hardness tests were carried out on the specimens after heating, and the results are given in Table V. Specimens were also heated at 250 deg. C. for periods of 10 minutes, 1 hour, 6 hours, 1 day, 5 days and 1 month, and the hardness tests are recorded in Table V.

Chemical analyses of the three coppers were carried out. Determination of the oxygen content by the precision method described by Baker* gave 0·0001 per cent. oxygen, which was almost the same as the blank of the apparatus. The copper content of O.F.H.C. was 99·98 per cent., of O.R.C. 99·971 per cent., and of C.C.C. 99·961 per cent. The oxygen content of O.R.C. was 0·019 per cent. and of C.C.C. 0·030 per cent. Spectrographic analyses of the actual wires showed that no important changes of composition took place during their preparation.

The differences in behaviour of the three coppers are sufficiently striking to deserve mention. In comparing the results, however, it must not be assumed that other wires from these brands of copper will necessarily behave in exactly the same way as those on which these tests were carried out. Although the analysis of each brand of copper has been accepted by the individual manufacturers as typical of their product, small variations in the amount and type of impurities may affect the behaviour of copper wires very considerably. In particular, it should not be

* Paper presented for written discussion to the Institute of Metals. Abridged.

† See ENGINEERING, vol. CXXVIII, page 446 (1929).

‡ Aluminium containing magnesium 0·4, silicon 0·5 to 0·6, and iron less than 0·3 per cent., quenched, cold-drawn, and annealed.

§ See *Metals and Alloys*, vol. 5, page 176 (1934).

‖ See vol. 1, page 250 (1938).

* See *Jl. Inst. Metals*, vol. 65, page 345 (1939).

assumed that other brands of oxygen-free high-conductivity copper will produce wires having the same characteristics as the O.F.H.C. material tested.

A useful basis of comparison is provided by calculating the percentage of hardening due to cold work remaining after the full 18 months at 80 deg. C., as assessed by ultimate strength. This percentage, given in Table IV, page 359, is expressed by the ratio :—

$$\frac{\text{Strength after 18 months at 80 deg. C. } \textit{less} \text{ annealed strength}}{\text{Strength as initially hard-drawn } \textit{less} \text{ annealed strength}} \times 100.$$

Even after the full 18 months at 80 deg. C. the strength of the O.F.H.C. copper was unimpaired in the thicker, and only slightly reduced in the thinner, more heavily drawn wire. The loss of strength was greater in the C.C.C. than in the O.R.C. Silver is well known to exert a powerful effect in retarding the softening of work-hardened copper, and it is probable that the greater reduction of strength in the C.C.C. on long heating at 80 deg. C. is connected with its low silver content (0·000062 per cent.). The O.F.H.C. contained more silver than the O.R.C. and was more resistant to softening. The silver (+ gold) content of the O.F.H.C. was 0·0017 per cent. and of the O.R.C. 0·0010 per cent. It is not suggested, however, that the silver content is the only, or even the predominating, factor causing the observed differences in behaviour. In the O.F.H.C., for instance, which is deoxidised without the use of deoxidants capable of entering into solid solution in the copper, impurities presumably exist in solid solution in the metallic phase and therefore exert their full influence in retarding the softening process. On the other hand, a proportion of the more readily oxidisable impurities in the tough-pitch coppers may be associated with the oxide phase and thus be prevented from exerting their effect upon the metallic phase. Both the tough-pitch coppers were, in fact, more rapidly softened than the O.F.H.C. Whatever may be the causes of the differences in behaviour, it is interesting to note that they persist under more drastic annealing conditions, as shown in Table V, page 359, which gives hardness tests after various treatments on samples of the same O.F.H.C., O.R.C. and C.C.C. coppers in the form of ⅛-in. diameter rod initially cold-drawn to 50 per cent. reduction of area. The figures for the percentage of remaining work-hardness are derived in the same manner as that described for the wires, using the hardness numbers after 1 hour at 600 deg. C. as the fully annealed values. Tables IV and V place the three materials in the same order in respect of annealing behaviour.

The author is indebted to the Council of the British Non-Ferrous Metals Research Association for permission to publish the paper, to the manufacturers mentioned in the text for the provision of material, together with detailed analyses and other relevant information, and to Messrs. Thomas Bolton and Sons, Limited, who prepared from the wire-bars supplied all the wires used in the tests.

THE WELSH TIN-PLATE AND STEEL SHEET MARKET.—The current weekly report of the Incorporated Swansea Exchange, 1, St. James'-gardens, Swansea, states that tin-plates are in better demand than has been the case latterly, and that a fair volume of business has been done in plates for both home and export delivery. Galvanised and other steel sheets continue to have a strong priority demand and the producing works are fully employed.

SAFEGUARDING PRECISION TOOLS.—The Electricity Commissioners have called the attention of electricity undertakings to the fact that all precision tools, small machine tools, portable instruments, etc., should be lodged in some safe place each night when not in use; for example, in an air-raid shelter. It is, of course, important to minimise the risk of such equipment being destroyed or lost, because of difficulties of replacement.

REGISTER OF BRITISH PROPERTY IN ESTONIA, LATVIA AND LITHUANIA.—The Board of Trade has announced that a register of British assets in Estonia, Latvia and Lithuania is being prepared by the Finance Department, Romney House East, Tufton-street, London, S.W.1. To bring the work to completion, the Board requests any person having such assets to register without further delay. The object of the register is to provide a record of real and personal property, belonging to British nationals, situated in these countries, and also of debts and other moneys outstanding. Debts insured with the Export Credits Guarantee Department should also be registered, even though a claim has been met by that department, and the particulars of the insurance should be given. A separate form is not required for each debt or property, but applicants should state the number and general nature of the debt or property when applying for forms.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

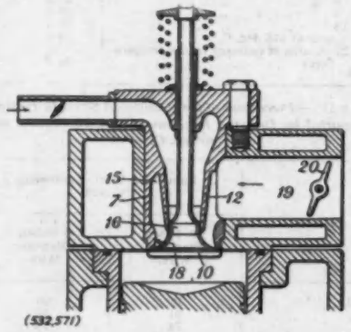
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

INTERNAL-COMBUSTION ENGINES.

532,571. Gas-Engine Inlet Valve. H. F. P. Purday and F. E. Rebbeck, of Harland and Wolff, Limited, of Belfast, and N. McCallum, of London. (3 *Figs.*) September 8, 1939.—The valve is of the kind in which a main valve controls admission of air and gas to the cylinder, and an auxiliary valve on the stem of the main valve controls the supply of gas for admixture with the air passing to the main valve, and its object is to enable the gas to be supplied at or below the pressure of the air supply while ensuring that the proper proportion of gas is drawn into the cylinder. The cylinder head, in which is formed an air-inlet passage 19, has a valve casing 7 inserted and bolted to it. At its lower end, the valve casing has a seat for a main valve 10 carried on a valve stem, which passes through a gas-admission tube 12. A lateral opening in the valve casing connects a space 15 around the tube 12 with the air inlet 19. A cylindrical valve piston 16 is fixed to the valve stem and works in a cylindrical part in the gas tube, the end of which



(532,571)

opens into the space 15 close to a contracted throat 18 behind the main valve seat. The valve 16 is arranged to open the end of the tube 12 shortly after the main valve 10 opens. The cross-sectional area of the passage through the contracted throat 18 is such that the velocity of the air flow through it produces a region of reduced pressure at the throat 18, which induces gas flow through the tube 12 when the valve 16 opens. This arrangement of valves enables the proper proportion of gas to be drawn into the cylinder during the normal running of the engine without necessitating the closing of the throttle valve 20 to produce a pressure drop in the air-inlet passage 19. At the same time, the quantity of gas drawn into the cylinder increases with increase in the quantity of air drawn in, whereas hitherto the quantity of gas drawn in has been increased by throttling the air admission and reducing the quantity of air drawn into the cylinder. The throttle valve 20 is provided only for regulating the amount of the charge drawn into the cylinder. (*Accepted January* 27, 1941.)

SHIPS AND NAUTICAL APPLIANCES.

531,242. Motor Torpedo-Boat. H. Scott-Paine, of Hythe. (6 *Figs.*) March 25, 1939.—The invention is a motor torpedo-boat which is inconspicuous as a target but which has good sea-keeping qualities in all weathers and is capable of high speeds in rough seas. The vessel is of the hard-chine type and is constructed so that the sheer lines of the gunwale provide a smoothly-curved contour extending from a high freeboard portion forward to a lower platform aft. The vessel shown is of the order of 70 ft. in length, the still water-line being shown chain-dotted. The freeboard between this line and the deck at the forward end of the boat is about 5 ft. and at the aft end about half this amount. The maximum headroom available below the deck is not substantially greater than the height of a man. The wheel-house floor 14 is below deck level, but is of substantially less width than the beam, so that the wheel-house projects the minimum amount above the deck. Flattening of the camber and sloping of the deck downwards in front of the wheel-house gives a low sight-line. The sides of the boat are flared outwards and the stem itself is flared forward to secure continuity of this feature. The wheel-house has a conning bridge constituted by a cockpit 62 which opens through the roof of the wheel-house to command the whole of the boat, its floor 52 being above the level of the floor of the wheelhouse. Access to the conning bridge is from inside the wheel-house by a watertight door. The wheel-house occupies nearly half the length of the vessel and is arranged approximately in the middle of it. Three watertight bulkheads. 15, 16, 17, below the deck line and underneath the wheel-house, divide the boat into a compartment 21 with full headroom constituting the crew's quarters, a compartment 156 for officers and wireless, a compartment for fuel tanks,

Fig.1.

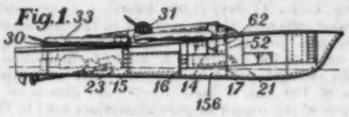
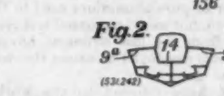


Fig.2.



(531,242)

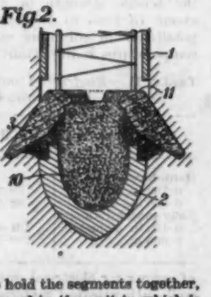
and an engine-room compartment 23, containing three engines. Access to the crew's quarters is from inside the wheel-house by a door forward of the cockpit. The compartment 156 has the floor 14 of the wheel-house in it and sleeping berths are provided under this floor, the remainder of the space beneath the parts 9a and 9b of the deck (Fig. 2) having full available headroom. The aft part of the wheel-house provides light and additional headroom in the engine room. The wheel-house provides communication under cover between all the compartments and the inconspicuousness of the boat is enhanced by the smooth and unbroken silhouette. The aft part of the vessel of low freeboard is of sufficient length to accommodate two torpedo tubes 33, and torpedoes are stored on the deck forward of these tubes. Additional armament is provided by automatic gun-turrets 30, 31, of the enclosed type used on aircraft. The mast, bollard, towing post, and so forth, are housed below deck level when not in use. (*Accepted January* 1, 1941.)

MISCELLANEOUS.

535,548. Concrete Piles. The British Steel Piling Company, Limited, of London, and A. Hood, of Leatherhead. (3 *Figs.*) August 30, 1940.—The invention is mainly applicable to piles formed *in situ* with the aid of the usual preparatory pile-driving tube 1 and shoe 2, and consists of the provision of a separate precast unit to give increased bearing strength at the foot of the pile and greater stability to the pile. The separate unit is of precast concrete and is cylindrical, with four segments 3, made by dividing the unit vertically in radial planes at right angles to each other. The base is coned to form a penetrating edge at the bottom. The unit is expanded by a series of blows from a weight 7 which cause the segments 3 to spread out into the surrounding soil. The external diameter of the unit with the segments unseparated is slightly less than the diameter of the bore

Fig.1.

Fig.2.



(525,548)

hole for ease in lowering. To hold the segments together, a circumferential notch is formed in the unit in which is laid a cord for tying the segments together temporarily. A little concrete 10 is deposited at the bottom of the bore hole before the unit is lowered. After the unit has been lowered, the weight 7 is lifted and dropped on to it a number of times, driving the segments 3 downwards and outwards and compressing the liquid concrete 10. At the same time it prevents the upward flow of the concrete which enters and fills the hollow space within the unit and is thus simultaneously tamped firmly down. In order to assist the driving action, the top outer edge of the unit is bevelled at 11 so that, when the sections are driven for their full length into the ground, the weight strikes the bevelled surface of the sections. The pile is then built up on the splayed footing. (*Accepted August* 30, 1940.)